SCIENCE

30 May 1958

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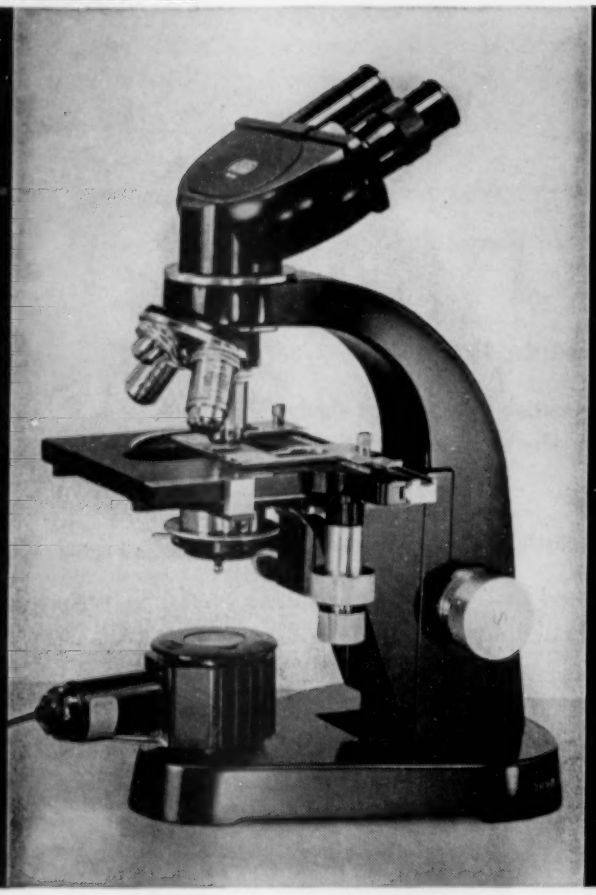

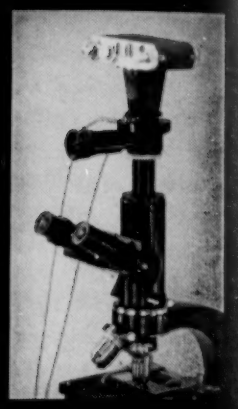

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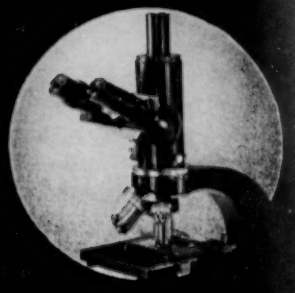

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The Complete Curriculum

Current proposals for increasing the emphasis on natural science and mathematics in college raise the question of what should be the proper balance in general education between science and the humanities. If we grant the need for more people with professional competence in science, as well as for more citizens with appreciation of the results of science, then the fear arises that our educational institutions will be turning out graduates with no interest in other forms of human endeavor and no feeling for the beauty of ideas.

The question of what elements must be included in a course of study if that course is to be complete is not new, and the attempts to answer it tend to follow a definite pattern. Imagine a conference of people with diverse academic backgrounds. Each participant will interpret his own special knowledge as a necessary part of any plan for general culture. The chief languages, modern history, ancient history, the latest results of science, the great novels—and we are still thinking only in terms of Western civilization—all must go in. Topic is added to topic until it becomes apparent that the participants are not just ignorant but utter dunces.

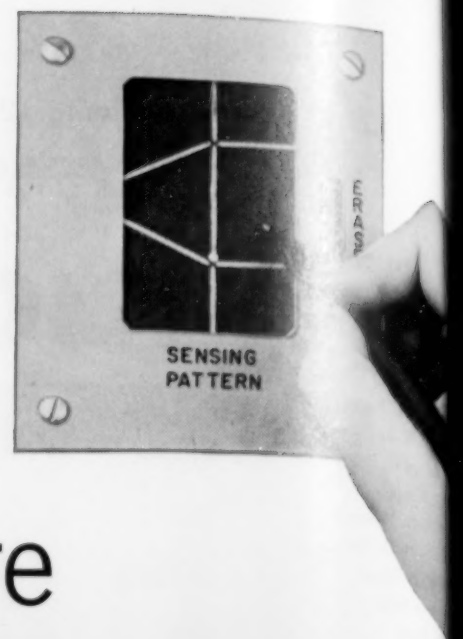
Fortunately, the way to avoid this unpleasant conclusion has also been worked out before. It is to argue that a curriculum for general education cannot be separated from one for special knowledge. Alfred North Whitehead put the matter very nicely in his collection of essays on *The Aims of Education* (reprinted as a Mentor Book). In the essay from which the volume gets its name he writes: "The subjects pursued for the sake of a general education are special subjects specially studied; and . . . one of the ways of encouraging general mental activity is to foster a special devotion."

Justification for this union of the general and the special follows immediately once it is granted that the goals of education have something to do with fruitfulness of mind. If the study of a given subject is to mean something more than the memorizing of a given routine, then the study of additional subjects is not necessarily the answer, for it may only mean the memorizing of additional routines. What is necessary is to set forth the principles by which knowledge is come by, but to do so at once in terms of a specific use and at the same time apart from that use.

To teach a branch of science so as to encourage general mental activity involves many things. At one level it involves presenting a body of knowledge *as* a body of knowledge—to the extent, that is, that connections among the parts have been established—not as a set of isolated answers to isolated questions. At a second level, it involves tracing the routes by which both the answers and questions are first suggested and the methods by which the answers become warranted as true. At a third level, it involves bringing to light the individual and communal values that make science possible.

With proposals on hand for increasing the emphasis on science, the first impulse for those concerned with general education is to call for a comparable increase in emphasis on the humanities. But what we are trying to suggest is that the way to correct specialization in science is more complex than seeking a point-by-point balance with other disciplines. A concern with broad coverage can become the pursuit of an unattainable ideal. Completeness in education moves not only horizontally but also vertically.—J. T.

Write a numeral here



and read it here

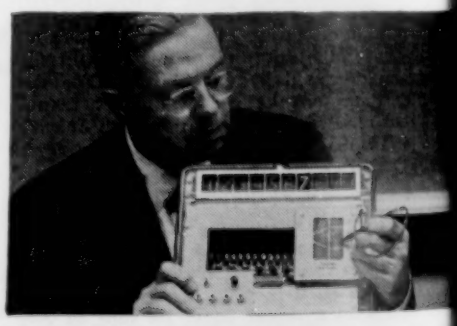
on new Bell Labs machine

A new device invented at Bell Laboratories "reads" a numeral while it is being writt and instantly converts it into distinctive electric signals. The signals may be employed t make a numeral light up in a display panel, as above, or they may be sent to a computer o to a magnetic "memory" for storage.

The writing is done with a metal stylus on a specially prepared surface. Two dots, on above the other, are used as reference points. Seven sensitized lines extend radially fro the dots. Transistorized logic circuits recognize numerals according to which lines are crosse

The concept of a number-reader has interesting possibilities as a new means of comm nication from humans to machines. For example, in an adjunct to a telephone, it might provide inexpensive means of converting handwritten data into signals which machines can read. The signals could be transmitted through the regular telephone network to a teletypewriter or computer at a distant point. In this way, a salesman might quickly and easily furnish sales data to headquarters, or a merchant might order goods from a warehouse.

Modern communication involves many more fields of inquiry than the transmission and reception of sound. The experimental number-reader is but one example of Bell Telephone Laboratories work to improve communications service.



Tom Dimond, a B.S. in E.E. from the Un versity of Iowa, demonstrates an exper mental model of his number-readin invention. A similar device can also be ma to read alphabetical characters. Small si and low power requirements result fro transistor circuitry.

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30 May 1958, Volume 127, Number 3309

SCIENCE

Machines and the Brain

Mathematical logic helps design complex nets whose arrangements resemble the structure of the brain.

F. H. George

There has been a great deal of work ne in the last few years that is designed place biology on the same sort of thematical footing as physics. Physics ade great progress after it had been en just how mathematics could be ed to describe physical phenomena. his was done in such a manner that ductive processes could be quickly and ethodically undertaken, and these in rn led to all sorts of discoveries of ysical importance.

The process of using mathematics in cience is not unlike that of discovering at a piece of territory that one wants map is sufficiently similar in structure a map that he already has in his pos- ssion that he can study the map and ticipate the territory accordingly. This s still not been done to any great ex- t in biology, in spite of the fact that ny people have felt that physics and logy are essentially similar in their ical form. In some cases it has been ought that biology is *reducible to* phys- . We shall not argue these matters re, but shall try to make a direct com- rison between the sort of "maps" that thematicians have produced and the logical facts. That part of biology at we shall consider is the structure and nction of the brain, and especially the ual part, that is, the visual system and cortical representation.

George Boole was the founder of odern mathematical logic. He saw that could construct an algebra which seemed to be capable of interpretation as a practical logic. This meant that the variables, or unknowns, in the algebra were capable of being interpreted as the ordinary sentences of spoken language. He thought that this sort of mathematics rigorously represented the laws of human thought, although since then it has been felt that it actually represents something like *ideal* rather than actual thought. Nevertheless, the discovery was of the utmost importance.

Walter Pitts and Warren McCulloch took the next step quite recently, many years after Boole, when they saw that the brain is rather like a machine that can be described by a mathematical system that has values of its variables of 1 or 0, according to whether the pulses of the nerve cells (or switches) are *live* or not.

Cybernetics is now well known to have seriously proposed that the brain is a control and communication system within the sense of the definition for physical systems, and is, in effect, a complex switching device, indeed, a two-valued switching device. Thus McCulloch himself thought that propositions, or ideas, concepts, and the like, are nervous impulses "on the move," as he put it. Again, the object of this article is not to consider any of the philosophical difficulties that these ideas meet; I shall simply concentrate on describing quite quickly the idea of a logical net.

A logical net is the simple geometrical realization of mathematical logic that has a form that is similar to, and perhaps can be made identical with, the structure of the nervous system, although we cannot be sure of this until we have discovered a great deal more about the structure and function of the human nervous system.

Those people who have taken their mathematical studies up to the stage where they see that algebra is capable of being wholly mirrored in geometry, or where geometry can be made wholly algebraic—that is, after a certain stage there is no distinction between algebra and geometry since all of geometry becomes algebraic and does not demand the drawing of diagrams—those people will see the same situation here. It was Descartes who saw that by taking a sort of trellis, or mesh, and measuring an x-value along one scale and a y-value along another, all geometrical figures can be put into an algebraic form. Here we see that the actual net as a diagram has an associated equation from mathematical logic. When we bear this in mind, it is clear that the whole structure of networks can be investigated from a purely mathematical point of view, at least in this sense; they are abstract nets, and to make them, like our maps, fit any particular territory means that we must first look very hard at that territory. This is the ultimate aim in this article: to see how the territory accords with the mathematical development so far.

Logical Nets

A logical net is made up of elements and connecting fibers. These elements can be divided up into those that have both input and output fibers, those with input fibers only, and those with output fibers only. Clearly one has in mind here the neurons and their axons, and dendrites, and these are divided into internuncial, sensory, and motor neurons. However, we should be careful initially merely to describe such nets as logical rather than *neural* nets. This is important because the nets will, initially at any rate, only superficially resemble the structure of the actual nervous system.

Each element has a threshold number which represents the number of input fibers that have to be simultaneously fir-

The author is on the staff of the department of chology, University of Bristol, Bristol, England.

ing to effect a firing in the element, and thus make the output fiber fire. In this respect we should say that there are two sorts of fiber endings that impinge upon elements, and they are either excitatory or inhibitory (represented by filled-in triangles and open circles, respectively, in Fig. 1). Furthermore, we need to include elements of a certain kind that have loops on them. This means that the output fiber is also an input fiber for the same element (see Fig. 1). There are one or two further rules that say that elements can be in only one of two states, either they are *live* or they are *not live,* and an element will fire at time t if and only if another element whose output impinges on the first element fires at $t-1$. We should also notice that time is assumed, at least initially, to be in a set of equal intervals, which are the firing times of the cells in the net. This is obviously something that is untrue of the actual nervous system. However, for initial investigations, as with mathematical physics, where we talk of ideal spheres without friction, and so forth, this is a fair, and even necessary assumption. This means that differences in synaptic delays and refractory periods in nervous tissue are ignored, but this can be compensated for by introducing delay units to achieve certain patterns of nets, even though the temporal delays and patterns necessary to proper nervous activity are not yet being reproduced in these logical nets.

We can now achieve great complexities if we take a sufficient number of these elements and string them together in very complicated networks. Such networks of elements have properties that can be stated mathematically. This is clear when we remember that every network is precisely defined in mathematical terms. There is a characteristic equation associated with each and every net. Kleene, the American logician, has shown that, by use of the propositional calculus and a little more, any of the networks that we may want are capable of being realized. The propositional calculus is simply Boole's algebra of classes where the variables are propositions and the connectives of ordinary language such as "and," "or," and "not" are to retain their ordinary meaning. The phrase "little more" refers to a small fragment of what is called the functional calculus. There is a need for functions and an existential operator, so that we can say "there exists an element such that it has been fired at some time in the past." This is a difficult matter to explain, and it is unnecessary to explain it here, except to say that this extra bit is necessary because of the loops on elements that allow them to go on firing for any length of time, once they have been fired. This mathematical system which has time suffices to define the net completely. Let us give some simple examples for Fig. 1. The element K^2 fires if and only if S^1 and S^2 fire together at the previous instant. Thus

$$K_t^2 \equiv S_{t-1}^1 \cdot S_{t-1}^2$$

where $\equiv$ is *if and only if* and $\cdot$ is *and.* Similarly, for L^1 and L^2

$$L_t^1 \equiv S_{t-1}^1 \cdot \sim S_{t-1}^2$$

$$L_t^2 \equiv \sim S_{t-1}^1 \cdot S_{t-1}^2$$

where $\sim$ means *not,* and so on for all the other elements.

Machines

We should say that logical nets are effective means of designing a machine, since we know from work on digital computers that we can realize, in electrical circuits, all the logical relations that we need to build the logical nets. This is very important, because it tells us that if we can construct a logical net with pen and ink and paper, then we have given a blueprint that could be directly translated into a hardware machine.

The machines that have been built so far are numerous, but one should especially mention Grey Walter's *Speculatrix* and *Cora,* Ross Ashby's *Homeostat,* Uttley's classification and conditional probability machine, and *Eucrates 1,* a machine recently built by Solartron for commercial purposes. All these were built in Great Britain, and many more have been built in the United States. These machines are all capable of being drawn up in logical network blueprint form, although in each case, as far as I know, they were in fact built otherwise than *from* such a plan.

The main use of logical nets is that one does not necessarily have to build the machine to know that it would work, although sometimes this is desirable and suggestive for design purposes, especially when such machines are likely to have commercial application. However, when the end is biological, and that is the only one that we are considering here, the logical nets themselves have great advantages, for it is possible to consider large aggregates of elements which involve an enormous machine, without actually having to build it. This is a method of approach to a theory, a mathematical theory, of the nervous system.

Digital and analog computers have made contributions to ideas about how the brain works, by emphasizing the importance of methods of storage. Here again the difficulty is that the methods of effecting a very similar end might, in the organism, be radically different. It is certainly one problem to build a machine that will do what a human does and a different one to build a machine that will do what a human does by using the same *structure* and *functions.* It seems to me that the work of the engineer in building the machines of the feedback type so far built is of the greatest interest to biologists, but it must be admitted that opinions are divided on this matter. The nature of explanation in biology is still under dispute to some extent, but, even among those who favor what is called mechanistic type explanations, there are some who see no value in the suggestions of cybernetics.

Development of Nets

The next stage in the development of logical nets is simply to discover as many of their properties as possible, by mathematical and intuitive means. This has led to a sort of conceptual nervous system which has been of great use, or perhaps one should say will, it is hoped, be of great use to psychologists who wish to think of humans as machines having certain special properties that can be investigated. This can be done both for individual nets and for groups of nets. But I shall leave this matter for the time and just mention that some aspect of this subject has already been investigated under the name of *theory of games.*

It would seem necessary to outline very briefly what the present network model of a human being suggests. I shall be brief because the details have already been written up elsewhere, and I shall not pursue the question of the conceptual nervous system explicitly here, for that too has been written up elsewhere, but I shall go straight from a discussion of the properties of nervous nets and machines to a consideration of work done by neuroanatomists, electroencephalographers, and the like. This work is still too indefinite to give us any final picture, or anything even approaching a final picture, but it does at least suggest a tendency. First, though, let us take our description of logical nets a stage further.

It should be said that one lesson we

e learned fro digital computer de- is that senso systems are similar to ssification syst ms. The punched-tape punched-card system used for filing ormation nee s a sensing system that fired when a hole on the tape or card sses under a wire fiber. Now, briefly, se fibers could be the fibers of the put elements of a logical net. This ans that we could have a whole set such input elements labeled *a, b, c,* . *n* which are fired or not, either in- idually, in twos, or threes, or any mber at all, up to *n* at once. There y be vast numbers of these basic in- t elements that can be subdivided into s. These sets would correspond to the ferent senses such as visual, auditory, d so forth. Now a physical object, ich has (or *is*) a set of properties, ch as being red, round, tall, and so rth, will thus be an aggregate of basic puts firing, giving some pattern such as *djkrst,* say. We can now easily arrange have logical network counters that cord how often certain collections of put elements have fired together and w often they have not. Thus the ma- ine, or organism, will be in a position know that if *A* occurs, where *A* is me long string of basic input elements ch as *acdjkrst,* then *A* is followed by *B,* some other such string, and this will be followed by *C,* and so on.

This ordering of strings of properties may be simple—that is, it may simply be a matter of observing or it may be a matter of "*A* follows *B* if and only if the machine does *A′* or *B′*," or again it may be that in either of the above two circumstances sometimes one thing follows, or again sometimes many things. These many things could be mutually exclusive or not. Thus we may say that whenever I see smoke I see a fire, *if I go and look for it.* Or perhaps if I see a shoe I sometimes see a man in it, and sometimes I don't. And so on.

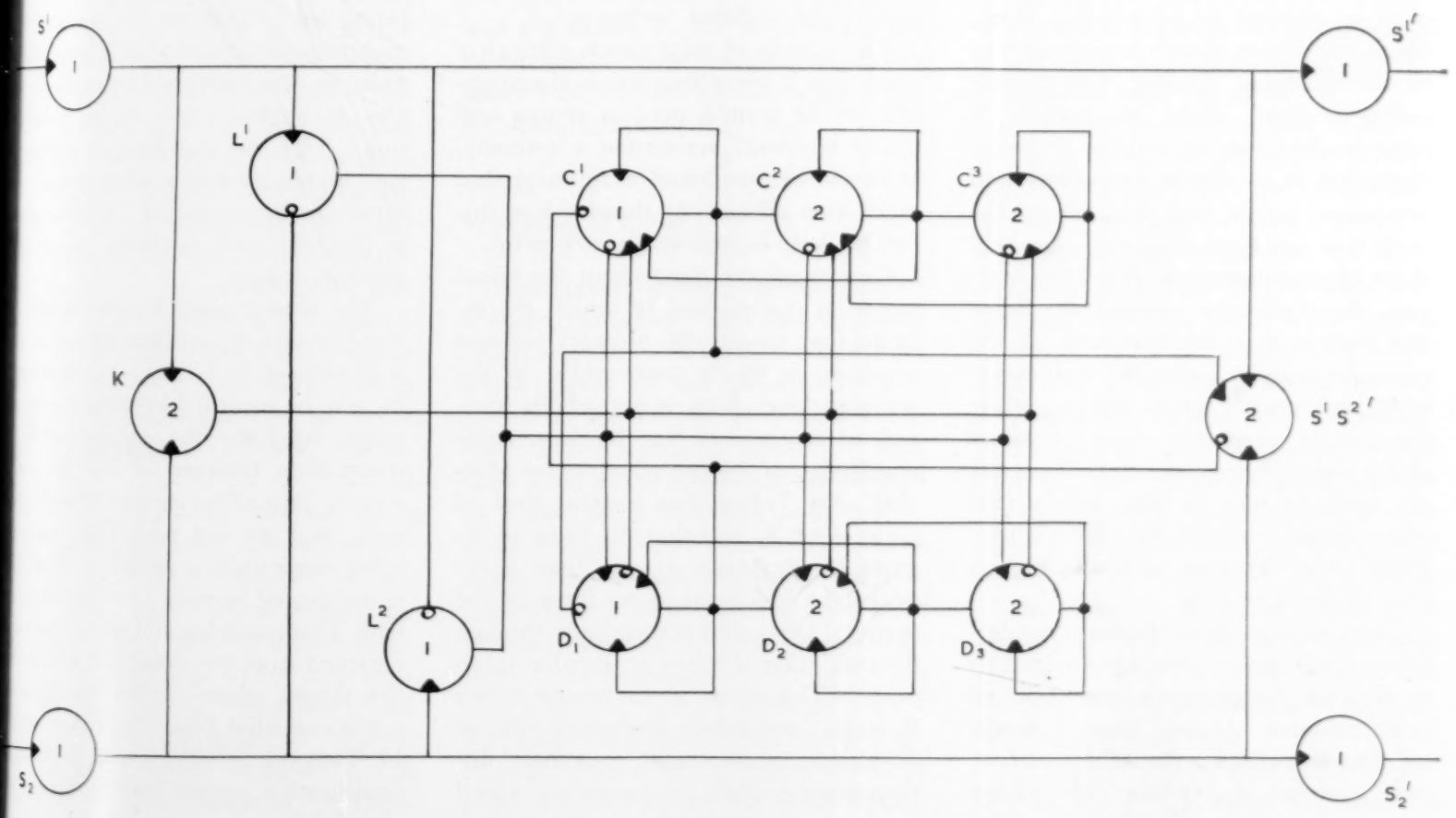
The set of conjunction counters and disjunction-counters, as they are called, is shown in Fig. 1, which is a simple net capable of recording the occurrence of *a* and *b* together once or their nonoccurrence together once. The reader should trace out what happens to the net when *a* fires alone, and when *a* and *b* fire together, and when this happens in different orders. The loop will be seen to be the memory store, and thus the elements *C* and *D* are the store, which we have called the conjunction and disjunction counters, since they effectively count occurrences, although only up to one each here.

In the case of making an inference, this is possible for the machine, if it is seen that if *A* leads to *B*, and *B* leads to *D,* then, granted that the conditions of observation are adequate, it will be seen that *A* leads to *D,* contingent or otherwise on some response on the part of the machine.

Further than this, work has been undertaken showing how *consciousness* might arise in such a system, how generalizations might be made, how habits are broken suddenly as well as how activities are modified over a period of time. Indeed, much more of the behavior studied by psychologists can be mirrored in such terms. Let us assume that a great deal can be done along these lines to provide a conceptual nervous system, and let us now concentrate on the other question of how such systems fit in with neurological discoveries.

The Nervous System

We have at this stage arrived at some picture of what the cyberneticists have been talking about. We gather that they can design a machine that can classify its environment and can remember, and make inferences, and behave in many



ig. 1. Network made up of elements (large circles), with input wires (left) and output wires (right). There are two sorts of endings the input wires on the elements. These represent excitatory (solid triangles) and inhibitory (small open circles) inputs when the put wires carry a pulse. The number written inside each element is a threshold number, and measures the sensitivity of the element stating the preponderance of excitatory over inhibitory inputs that must be firing at any instant in order to fire the element—that to produce a pulse in the output wire at the next instant.

ways like an intelligent organism; now we shall compare the means which it uses with what we know of the human organism. Let us first look at the visual system, for this system is better understood than most.

We have learned a great deal about the human visual system, and I shall try to summarize very briefly what that knowledge amounts to. In the first place we know that the retinas of the eyes are the origin of the internal stimuli that travel from the periphery of the body, carrying information about the external world, to the brain. The retina itself is complicated enough, being made up of at least two kinds of nerve cells called rods and cones, and possibly also a third kind, the rod-cone. The nine layers of the retina, with their different sorts of connections and their lateral cells, are themselves a complete study, but at least we can see that the retina serves the purpose of recording two sorts of incoming sets of stimuli.

The cones and rods are separable primarily through their function in color vision and twilight vision, but also through rod areas and predominantly cone areas—those areas that are nearest the macula, a rod-free area centrally placed at the back of the eye. These areas are to some extent separable in terms of their function. They carry epicritic as opposed to protopathic fibers, which was Henry Head's functional way of distinguishing detailed from crude and generalized visual information. A more modern way of making a similar distinction is to discuss modulator and dominator curves, and this reflects the work that has been done with the help of the electroretinogram. Primarily, however, the distinction remains the same, and that is that the periphery of the retina tends to be concerned with movement and grosser visual effects, while the central parts are those of visual acuity and attention to detail. Thus the eye tends to turn in such a way that where detail is needed the object is projected onto the area with the highest ratio of cones to rods.

There are various artifactual considerations about the eye that have helped us to discover the processes that different areas subserve. Among these I might mention as examples the effects of contrast (the fact that white looks whiter on a black background), the fact of figural and movement after-effects, which can be summarized as distortions of the appearance of things both static and moving that result primarily from incidental properties of the eye, such as the lag in refocusing, and the backlash of the adaptive retinal processes. Also important are eye movements that are, according to one well-know theory of visual acuity, essential to the resolution of detail in the eye. However, there is a world of detail and discussion still possible on the retinal part of the visual system alone, and I must leave that now and trace the visual pathways back to the brain proper.

At the optic chiasma, on the route back, half of the fibers from each eye cross over to the other side of the brain which, it will be remembered, is in two symmetrical sections, and half of the fibers stay on the same side. This is necessary to continuity of vision across the visual field, and it results from binocular vision in man. The optic track then courses directly to the thalamus where it terminates on successive laminae of a part of the thalamus called the lateral geniculate body. Here connections are made with the second-order neurons of the visual system. From here they radiate to the striate areas of the occipital lobe at the back of the head.

Perhaps the most interesting feature of the visual pathways is the effect of summation resulting from the fact that information is being passed through a restriction. (Something very similar is seen in the auditory pathways.)

The passing of information through a restriction is something that is characteristic of the central nervous system and makes temporal summation a necessity. It should be mentioned straightway that there is no difficulty in showing how this can be done in logical network terms.

One significant thing about the visual system is the method by which the information, passing by ordinary nervous impulses, is finally reassembled in the occipital lobe. This is not wholly verified, by any means, but the theory, primarily that of the two physiologists Marshall and Talbot, has a great deal of plausibility. It says that the firing of regions in the retina at any time is repeated in much the same form in the occipital lobe, after transmission through the restriction of the optic fiber has taken place. (This firing of the retina occurs if, apart from subtle matters of relative thresholds in the retina, something distinguishable—that is, possessing visual gradients—is projected onto the retina.) The firm contour line is represented in the occipital lobe as the statistical peaking on the area of maximal distribution.

Whether or not such a picture of the recording of the epicritic detail is correct, it is certainly fairly near to the truth. It cannot actually be said that vision ends here, since the rest of the occipital lobe is concerned with visual elaboration, and this in turn is continuous with the rest of the cerebral cortex with its complex activities of storing information and acting on that information, being able to generalize and make inferences, and so on. It is fairly clear that the processes are not altogether separable, and one of the characteristics of visual activity is the fact that essential processes such as recognition, which is visual, depend on the registering of the necessary responses emerging from the incoming messages from the eye, but are also dependent on a comparison of some sort being made with the information already in storage.

Our main question is not whether we can build a machine, or a piece of machinery, that operates like the visual system; this much is taken for granted provided we can give a sufficient description of the visual system. But the question is, whether we can make predictions in terms of our knowledge with respect to the human visual system.

Our picture of the visual system, as will be remembered, is of a classification system. The retina seems to be a classification system involving two sorts of information. (Compare the way one can recognize physical objects in the environment by reference not only to visual, but also to auditory and tactile, classification.) Thus the classification is divisible into subsets of independent stimuli, and these can be correlated into patterns. It is precisely such patterns that we call physical objects.

The second point we should notice is that the sort of classification system that is introduced by Uttley is one that would have to be regarded as being at a microscopic level for the purposes of direct comparison between it and the visual system. This offers no difficulties in principle, and we can regard the retina as being made up of a mosaic of points that is duplicated in area 17 of the occipital lobe. This could be, and indeed has been, regarded from the viewpoint of information theory, where the information is being transmitted from the retina to area 17. Thus our interest is that the essential classification occurs in cells in the occipital lobe.

What of the disjunction, and conjunction counters that we have postulated as necessary to counting the occurrences of certain sets of stimuli? Here, of course,

the visual system we have so much
undancy that we should not need an
ct count; rather, it is clear that our
eral processes of recognition depend
our being able to recognize some part
the total context and to make gen-
lizations from such a sample.

It looks as if the area in which dis-
ction counters and conjunction count-
predominate is the temporal area of
cortex, where stimulation elicits
mories in conscious humans. This
s not imply that this is exclusively
place, but rather it is a place of
ximum concentration. This point also
es the question of reverbatory cir-
its.

We already know that there are such
ngs as reflexes and negative feedbacks.
r example, the pupillary reflex tends
keep the retinal receptors under con-
nt excitation by adjusting the diam-
r of the pupil inversely with respect
the brightness. Such feedbacks are en-
aged by Marshall and Talbot as being
the visual route back to the visual
rtex. This damps excessive stimulation
d amplifies inadequate stimulation.

It is also the case that there is a map-
g of the retinal points on the mid-
in which causes a reflex centering of
jects seen in the peripheral visual
ld, already mentioned, by minimiza-
n of the polar coordinates. Of course,
translation of retinal maps to the
dbrain and to the cortex may involve
the well-known transpositions of ro-
ion, reversal, and so forth, but the
pological properties of the original
inal mapping seem to be maintained.

We can go on multiplying the detail
the visual system by introducing the
pha rhythm as a scanning system that
sets the blurring and lack of sharpness
e to aftereffects of the retinal stimu-
ion. All these properties have obvious
echanical analogies that can be repre-
ted in somewhat idealized mathe-
atical form.

We want now to go beyond these
sser feedbacks to the reverbatory cir-
its that have been observed in the
rebral cortex itself. These seem to be
cessary to the storage of information.
rather, they seem to be the most con-
nient way of storing information, and
method that is probable, in view of
e evidence of such observations as
ose of the great American physiolo-
st, Lorente de Nó. The frequently ob-
rved overlap of cortical function
upled with the apparent adaptation
cortical cells to repeated stimulation,
ggests that the delicate timing of re-
sponses, or rather their *ordered* nature, becomes a consideration of the first importance. Thus we come to see, as indeed we should have done independently by pursuing our logical nets. We see that the ordering of the stimuli that make up the input turn out to be a vital characteristic. Thus an ordered set that is interpreted as A (and this may involve any degree of complication in the pattern of the primitive stimuli making up the stimulus A) will itself be an influence in deciding the nature of the next signal. Thus, very simply, things that have happened once are seen as more likely to happen again than those things that have not happened before. Thus a state of expectation, or set, is the weighting of contingent probabilities with respect to the ordering of signals in the nervous system. Such a state of affairs is at least consistent with what we know of cortical, or general neural, stimulation.

If we see the sensory classification system as taking up one large part of the brain, it is certainly true that a motor classification system takes up the other part. Thus we have a limited number of gross behavioral responses by action of glands, movements of muscles, and so forth, and these may be complex and intermingled. Thus we may expect that the direct responses that are associated with the sensory classification system will themselves be mapped onto some smaller subset which makes up the range of the individual's capacities.

Weighting of Events

There is now nothing essential needed between the sensory and motor classification systems except the storage system which makes up the counters. In fact, of course, there is, in the human being, more than one type of memory in that there seem to be things that are elicited on a short-term basis and those that require "digging out" from the unconscious. Here we are needlessly multiplying entities if we think of two different processes, because the same process, subject to two conditions, which are in any case necessary, will be sufficient. In the first place the organism has methods for allowing more weight to recent as well as more frequent events, for equal values. It also has a way of ascribing different values to events.

The recency factor can be taken care of in a variety of ways, the most likely being the gradual destruction of counts that occur through random firing and through various forms of interference in the very complex cortical picture, and especially where values are not high. What I mean by saying that values for the organism are high is that certain events are associated with other events that have high value for the organism in reducing a state of need, either in direct terms, by alleviating hunger, or the like, or indirectly, by contributing toward a state that will reduce a need. The extent to which the need is reduced is what we call, in self-conscious terms, the degree of feeling of satisfaction; this is what must also be recorded, and this is the value of the event.

Neurologically, the projection fibers from the hypothalamus and the lower centers, especially those concerned with the autonomic system and running to the frontal lobes, would seem to fit with the selector or motivational system of the logical net theory. It was always clear that the brain, acting as a logical machine, would not have the same efficiency as a counter for all events and their "togetherness." This is accounted for in part by the selective nature of the aggregates of input elements in the eye, in the human, which, because of the alpha rhythm, and other "errors" yet to be discussed, will not give equal weight to all external events. But even more, this bias that is placed on external events is due to the valuation that is accorded in terms of need reduction.

It should perhaps be said explicitly, to avoid giving the impression of gross oversimplification, that the complexities of values are enormous and a matter of great individual differences. It is all complicated further by self-consciousness and reflection, which is the process of stimulus-response activity of a covert kind that allows the firing of the sensory classification and motor classification systems by internal means, without involving the organism's going through the actual motor responses at the muscular or glandular level. This is part of what we call imagination and thinking.

The point of the above remark is to remind the reader that it is not always the actual value of need reduction so much as the believed value of need reduction that is so vital.

At any rate, the ability of the organism to avoid unpleasant consequences and to find pleasant ones lies in the "stamping in" of certain responses and the "stamping out" of others. One soon learns *not* to put one's hand in the fire, but one soon learns to put one's hand

in the chocolate box. All of this is easy enough to incorporate into machine design; the problem is to find the detailed system responsible in the human. It would seem to be primarily a matter for the autonomic system, but it is also more complicated than this suggests.

Work on electrical stimulation of the hypothalamus of cats has shown what is called "sham rage," but recent demonstrations of the cortical representation of the autonomic system, coupled with the apparent meaninglessness of sham rage (hence its name), have convinced most people that the hypothalamus is only a relay center for the "emotional" system. Ultimately emotional behavior can best be understood in the light of reasonable behavior and it must involve the storage system of memory, since clearly recognition will normally play a vital part in it. Again we can introduce counters, as has already been done for ordinary association purposes, where it is not the actual count so much as the general dimensions of the count that is important to allow the passing of information indicating which are highly satisfactory impulses and which are not. Thus a correlation will be set up between satisfactory responses and certain signs in the environment, which will in turn condition what we call the person's *choice*. Thus a selection of stimulus situations may be expected in terms of previous experience.

It is perhaps worth adding that we can now see how to model almost all the functions of the human. This means that we can mimic more or less every organismic activity, even to the extent that John von Neumann in America has shown that machines can be self-reproducing. Self-reproduction turns out to be primarily a mathematical problem, and its solution is of special genetic interest.

The interest in the attempts to solve these problems lies in the realization that we are gradually, by such methods, making biology mathematical. It is most striking when one hears that a purely mathematical solution to the question of reproduction turns out to have great interest for geneticists. The implication is that such mathematical methods are well suited to the task of such descriptions.

Lastly, we must bring ourselves down to earth to some extent. The human machine is far more complicated than logical nets may seem to suggest. In humans there are endocrine systems and other means of communication besides the nervous system alone. Moreover, the nervous system itself is made up of several millions of neurons, of varying sizes, with varying latencies, varying refractory periods, and so on. Thus we know that at best we can only hope to find out something about biological principles and in practice we shall need to reduce our definite descriptions to a probability level.

In the nervous system we could list a few of the factors that may make for difficulties of precise prediction: (i) the fact that the metabolic products of nearby cells, their concentrations, and gradients may well affect thresholds; (ii) electric fields in the nervous system, to say nothing of the five principal components of a wave caused by even an ordinary nervous stimulus; (iii) thermal changes in nervous tissue, and so on.

Even in spite of this we can talk of homogeneous random cubes of cortical tissue, where intercortical connections, and the subcortical connections, can be approximated by quite simple mathematical functions. But it is clear that descriptions are bound to be of a probability nature.

John von Neumann developed a theory of logical nets on such a basis, where errors of firing occur but where the errors are assumed to be small. These errors will not necessarily occur through inefficiency of the neurons involved but through the synapses being blocked by "emotional" responses (to take a probable example).

What we have to do is to try to recognize more and more of the mechanisms of the central nervous system, based whenever possible on the simplest conceptions of excitation and inhibition, such as central inhibitory and central excitatory states, as postulated by Charles Sherrington, and then to be able to suppose a mathematical function that can be shown to be sufficiently similar, by experiment and by other observations that would serve as a test of what is a hypothesis.

Ultimately, though, the idea must be that we should have a detailed account of the whole of the organism, a detailed and predictive account, which would not be used in practice to its full extent because of our vague knowledge of the effective inputs for the organism. Hence if given some idea of the inputs and some idea of the internal states, we want to be able to make a predictive statement about the subsequent behavior. All we can hope for is a probability statement, but we can perhaps make such statements fairly accurate. Logical nets and the field of cybernetics are trying to do just this. The link between the sort of systems that are *actually used* by humans and the machine analogies described are of increasing importance.

National Health Survey

Established in 1956, it is measuring levels, trends, and social consequences of various illnesses.

Forrest E. Linder

When, in 1956, Congress authorized establishment of the U.S. National Health Survey (*1*), the basis was laid for a major advance in the scientific measurement of the health characteristics of the nation's population. Before the survey was established, the inadequacy of the existing heterogeneous sources of morbidity statistics was generally recognized, and for years numerous agencies and committees had analyzed the needs, and sought solutions to the technical problems involved, and had worked to give impetus to new efforts in this field. However, until the National Health Survey Act was approved, the resources for sustained research were generally lacking.

The previously available sources of data on the extent and characteristics of illness were largely limited to the reporting by physicians of selected communicable diseases, a number of special and local one-time health studies and surveys, and scattered and disparate reports from hospitals, clinics, and health or hospital insurance groups. Whatever the quality and adequacy of these individual sources might be, their *ad hoc* and various character provided no basis for constructing a uniform and valid nation-wide measure of the essential features of the health of the American people. A single exception in the field of health statistics was the factual information relating to mortality. In this field the legal requirements for controlling the disposition of bodies and the many needs for legal proof of death resulted in the early establishment, in every state, of a system requiring the medical certification and official registration of every death. This death registration system has provided the data for an annual series of detailed, comparable, and nation-wide mortality statistics extending back for many years. These mortality data serve many scientific and administrative purposes in the medical, demographic, and actuarial fields, but the limitations of mortality data as an index of the health of the living population are obvious. However, in the absence of equally systematic and universal morbidity statistics, they have perhaps had a necessarily predominant weight in influencing the distribution of medical research and public health activities.

The usefulness of general morbidity data should require little emphasis, since numerous examples of the need for health facts are readily at hand. The direct private expenditures for medical care and for voluntary health insurance are estimated to exceed over $12 billion per year (*2*). It is not necessary to estimate individually the additional resources devoted to health in the form of such items as medical research, and the expenditures of national, state, and local governmental and nongovernmental health agencies, to make the point that health activities involve an important proportion of the country's material and human resources. Perhaps the remarkable feature is that this sector of the national economic and social life has not, long before this, been the subject of the kind of systematic statistical measurements that are so generally available for other sectors, such as agriculture, income, finance, prices, manufacturing, foreign trade, employment, labor, and population.

The primary users of generalized morbidity data are, of course, those persons responsible for the direction of operating health agencies. To them, an accurate appraisal of the extent and character of disease and of the social and economic factors related to morbidity is essential for effective planning and evaluation of their programs and for altering the scope and balance of their work. Originally concerned primarily with the control of the infectious diseases, the public and private health agency is now concerned with a much broader range of conditions. The factual basis for such work should be correspondingly broadened beyond the minimum figures on the incidence of those diseases, the reporting of which is required by law.

In a somewhat similar manner, morbidity statistics are needed for the planning and management of various aspects of social security programs, since total benefit payments for unemployment and disability are related in part to the volume and nature of illness and are affected by morbidity trends.

In a more tangential way such statistics have a contribution to make in the field of medical research, since clues to the etiology and pathogenesis of disease can often emerge from the study of the association between the incidence or prevalence of disease and various demographic, social, and geographic factors.

Of rapidly increasing importance are the direct economic applications of morbidity statistics. Some of these applications relate to improved evaluation of manpower resources, either for civilian or defense purposes. More generally, the economic loss of productive capacity through various types of morbidity is now recognized as an important and variable economic factor. The more stable component of this loss, which is attributable to chronic diseases or impairments, defines the magnitude of the need for rehabilitation of workers.

In another economic application, morbidity statistics related to demographic factors form the actuarial cornerstone for the development of voluntary hospital and medical insurance plans. As such plans increase in number and scope, health data covering all segments of the population become indispensable. Closely related to these uses of health statistics are the interests of drug and appliance manufacturers in estimating potential markets for new products and the use of such statistics for general guidance in market analysis and production scheduling.

Other countries have uses for morbidity statistics parallel to those in the United States, but the applications of health statistics extend beyond those that are strictly internal to questions of international health, particularly to the problems of evaluating international work directed to the economic and social development of the newly developing

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countries of the world. Both the United Nations and the World Health Organization have given attention to the methodological and conceptual problems of the statistical measurement of "levels of living" for the purposes of making international comparisons between countries or measuring change from one time to another. The measurement of the health component of the level of living is a part of this broader problem (*3*).

Morbidity Measurement Problem

The relatively slow development of the statistics of morbidity in the face of so many important uses for health statistics can be ascribed to the stubbornly complicated technical problems involved. Many of the problems of compilation are not peculiar to the field of health statistics, but in this field the problem of measurement is unusually difficult. In many statistical fields the unit of observation is fairly well defined and a limited number of specific uses for the data prescribe the character of the data desired in tabulation. In the field of health or morbidity statistics, the variety of uses of data becomes, itself, a complicating factor, since the group of phenomena to be observed have a multitude of aspects.

Referring again to mortality statistics, the fact of death is a clearly defined event, occurring only once for each person and at a closely determinable point in time. For morbidity none of these simplifying conditions exist. The concepts of health and illness are concepts that do not easily lend themselves to objective measurement. In morbidity statistics, according to the problem to be studied, the unit of observation may be the ill person, the morbid condition, the episode of illness, the medical service or treatment, or some other defined unit. Any of these units may be examined from differing points of view. For example, morbid conditions may be studied from the point of view of their prevalence at any given time or the incidence of new cases over a stated period of time. Illness itself is more often than not some indeterminate point on a continuous scale of well-being, from the best of health to severe sickness. In most instances, especially in chronic disease, the time of the onset and the end of the condition may be difficult or impossible to fix.

Even if the event to be statistically counted could be clearly defined and identified, it could be classified according to a large number of attributes. A morbid condition, for example, could be classified according to type in a number of ways, such as whether it is new, old, acute, or chronic; what the nature of the condition is; what the prognosis is; and so on. The condition could also be classified according to various measures of severity, duration, kind and amount of care received or required, consequences to the individual's family or to the community, and various other criteria. Each of the possible units of tabulation and each of the various axes of classification may provide the statistic required for some important application of the data.

The variety of types of data is paralleled by the variety of sources from which morbidity statistics of the different kinds can be obtained. These complicate organizational arrangements needed for the collection of data and introduce a bewildering variety of problems of data collection. A recent International Conference on Morbidity Statistics, called by the World Health Organization (*4*), considered more than twenty-four different major possible sources of morbidity statistics. The population and morbidity coverage and the uses and applicability of data from each of these sources were studied, but the problems in compilation are largely unsolved.

Even if interest were restricted to a single type of data from a single type of source, the technical and administrative problems of compiling national health data would be difficult because of the geographically diffuse character of the events to be studied. While this difficulty is not unique for health statistics, the situation in medicine may be contrasted with that in some other fields. Foreign trade statistics are derived from shipping documents which are administratively collected in a small number of export or import points. Manufacturing statistics are based on the reports of a limited number of manufacturers of a given product. Financial statistics derive directly from the operating records of banking and exchange institutions. The collection problems in such cases are relatively simple. In contrast, medical activities originate in the illnesses of millions of scattered people and operate through a complex system of thousands of independent physicians, clinics, hospitals, and other health care facilities. At no one point do the kaleidoscopic facts of these various health activities exist in comparable form, nor are they brought together in any automatic way to permit ready statistical observation.

There is perhaps another fundamental problem in the compil ion of mean ful health statistics. T s arises from fact that statistical me ures of healt morbidity take on the scientific m ings, as contrasted wi certain admi trative applications, on y when they be expressed as propo ions or rates is not sufficient to kn w, for exam that at a given time so many people such-and-such a popula ion group are with such-and-such a disease. The portant meaning of this aggregate fig emerges only when it is expressed in lation to the number of persons of same population group who at the sa time do not have the disease. Thus collection of data on sick people by c dition, age, sex, occupation, area of re dence, and so on, must be accompani by a parallel collection of correspond data for the population as a whole, s and well. Partly for this reason the co pilations of statistics based solely on re ords of hospitals, clinics, or medical pr titioners give only part of the need information and, by themselves, are re tively meaningless, except as statistics volume of medical services for certa administrative uses.

Program of the U.S. National Health Survey

The varied nature of the data desir for planning and evaluation in all phas of public and private health work an the requirement that corresponding i formation be obtained for both the and the well population determine th main lines of the policy and content the program of the U.S. National Heal Survey. The Survey is not a single su vey, with a single method and a sing limited objective. The Survey, as esta lished by Congress, is intended to be a intensive and sustained attempt to sol the major problems of compilation morbidity statistics, with due attenti given to the development of new met ods. The Survey is a program of survey which use different approaches and ha different end objectives as both the tec niques and the needs for data evolv But basic to all of the present and futur surveys is the fundamental idea that th data collection must pertain to a repr sentative group of people as the onl source where all of the desired facts con verge.

At its present stage of developmen the Survey program has three major as pects. The first is the continuing nation wide Household Interview Health Su

This survey, in which data are collected by means of skilled interviews with household respondents, is designed to give continuous information on the total volume of illness and disability, the medical care received, the nature of the medical conditions involved (to the extent that this can be obtained by the interview method), and various related demographic, social, and economic variables.

The second aspect of the program consists of other surveys, continuing or special in character, which are designed to obtain types of data not readily obtainable from the household survey. In view of the fact that the type of clinical information obtained by means of the household interview technique is not adequate for many medical research purposes, a nation-wide Health Examination Survey is now in the planning and testing stages. This survey will offer to a representative sample of the population a specially designed physical and clinical examination and will have as its objective a systematic inventory of specified clinical disease entities and the compilation of the frequency distributions of physical, and physiological, variables. The Health Examination Survey will give data expressed in precise medical terms, but because of the cost and the difficult logistic problems of this survey, the sample will necessarily be small, with the consequence that this survey will not yield the useful material relative to the social and economic aspects of illness and health that is obtained through the more extensive household interview survey. The difference between the methods and objectives of these two surveys illustrates the point that a single survey cannot serve all objectives. The special survey aspect of the program will successively develop other types of surveys as the program continues.

The third aspect of the program relates to studies of the methodology. Study of the pertinent methodology may be assumed in any scientific program, but special mention should be made of this part of the program. In the first place, a systematic development of the field of health statistics is so new that established and proven methods do not yet exist. For this reason the study of methods must occupy a prominent part in the Survey program. It is notable that the need for methodological work was recognized in the legislation creating the U.S. National Health Survey and that such research was specifically authorized. Methodological studies now under way are of several types. One type of study has as its objective the identification of gaps in data collected by the household survey. Other studies are preliminary to the design and execution of special surveys. For example, a number of studies are now under way which are preliminary to the final plan for the proposed Health Examination Survey. Other methodological studies have as their objective the evaluation and calibration of the data to be published from the various surveys.

Operating Plan of Household Interview Health Survey

In less than twelve months after the U.S. National Health Survey was authorized by Congress, the Household Interview Health Survey was operating on a nation-wide, continuing basis. The speed with which this survey could be established on a regular basis was due to two factors. In the first place, arrangements were made for utilizing the staff and facilities of the U.S. Bureau of the Census in many phases of survey design and administration; thus, advantage was taken of the pioneering work and experience of that agency in practical methods of population sampling and surveying. Under these arrangements, the field operations for the household survey are performed by the Bureau of the Census under general specifications established by the Public Health Service. In accordance with these specifications, the Bureau of the Census designs and selects the sample; conducts the field interviewing, acting as collecting agency for the Public Health Service; and edits and codes the questionnaires. Most of the editing, and the tabulating, are handled on the Bureau of the Census electronic computers.

Secondly, activities in the field of household health surveys were further advanced than were those in most surveys to determine other types of health statistics, and there was considerable previous survey experience, both in the United States and in other countries, which could be drawn upon in the design of the new U.S. Survey.

The first attempts by the United States Government to obtain data on illness directly from the persons concerned were in the population censuses of 1880 and 1890. These early nation-wide efforts to collect data on illness were followed somewhat later by a great variety of inquiries which were confined largely to special groups of people, single local areas, or special types of illness. These scattered studies provided no source from which an aggregate picture of the nation's health could be judged, but they did provide experience with different technical methods and demonstrated that the interview method could provide useful information about the amount and distribution of illness, the circumstances of injury, the loss of time from work or other usual activities resulting from disease and injury, and the utilization of medical care.

The next effort to obtain comprehensive data on illness in the general population was the National Health Survey of 1935–36 (*5*), a large-scale undertaking in which interviewers visited over 700,000 urban households to find out which members of the household had experienced disabling illness and which had specified chronic diseases or impairments. In the years since this 1935–36 survey, its findings have formed the basis for more than 200 reports, articles, and comparative studies.

Under a variety of sponsors, a number of additional studies were conducted after 1936 to provide large cities and states with needed statistics. Among the more important of these were the survey of the Eastern Health District of Baltimore (1938–1943); a methodological survey in San Jose, California (1952); the household survey initiated by the Health Insurance Plan of Greater New York (1952); the Baltimore Study (1952–55); the Hunterdon County Study (1951–55); and the state-wide California Health Survey (1954–55).

Surveys based on household interviews were also being organized in other countries. The Survey of Sickness in England and Wales was instituted in 1943 and continued until 1952 (*6*). Canada carried on a nation-wide sample survey for a 12-month period, starting in 1950, and Denmark organized a three-year survey program in 1951.

In designing the new U.S. Survey, an attempt was made to draw elements from this prior work, but there are many innovations in concept and in the statistical plan. In common with previous surveys, the Household Interview Health Survey rests on respondents within the household, inasmuch as this is the only source where the full range of facts about illness, good health, the person's demographic, social, and economic characteristics, the type of care sought or obtained, and the individual or family consequences of illness can be ascertained. The survey thus depends on a direct face-to-

face interview with some responsible person in a position to know the major health facts which are sought. For each household selected for interview, interviews are conducted with each adult member of the household, with proxy respondents permitted only for children or absent adults if related to the respondent. The present design does not provide for a reinterview at a later date, to collect follow-up information; hence, each selected household is interviewed only once (7). Questions are asked about the present health status of members of the household and about health experience during a retrospective period. This retrospective period varies for different items on the questionnaire but is generally a short period in order that errors due to failure of memory on the part of respondents may be minimized.

A very important feature of the survey plan is that the interviewing proceeds continuously, data being collected each week throughout the year. This continuous survey process has various advantages. Since data are collected each week, it is possible to compile weekly, monthly, or quarterly indexes of the various aspects of health to measure seasonal variation or time trends. However, many of the facts to be studied are the more fundamental relations between health and other factors, and the continuous collection of data permits the accumulation of information and, thus, successively more detailed tabulation and cross-tabulation. The continuous character of the survey also has administrative and technical advantages. For example, it is possible to use a smaller number of regular interviewers, who can receive constant training and retraining.

The corps of interviewers consists of approximately 130 permanent part-time employees who are trained and directed by 17 full-time supervisors located in Bureau of the Census regional offices. Training and checking of the interviewers' work is done through periodic group training sessions, assignment of homework, a systematic program of reinterviews by the supervisors, and a system of continuous flow of written instructions, performance evaluations, and reports on specific errors noted in interview technique.

The interview itself is based on a printed questionnaire and is "structured" in the sense that specified questions are asked in an exactly specified manner and order. The function of the interviewer is to follow the procedure according to instructions and to record accurately the replies of respondents. The interviewers learn how to ask the questions and how to record the replies. Their responsibilities are to act as reporters of facts rather than to attempt to be lay diagnosticians of the household ailments.

The questionnaire in use during the first survey year (July 1957–June 1958) consists of the following major parts or sections:

1) *Administrative items*: location and identification of household, record of calls, reasons for noninterview, editing control record, and so on.

2) *Demographic items*: identification of each member of household, relation to household head, age, sex, marital status, education, work status, and so on.

3) *Illness probe questions*: questions designed to aid the respondent's memory in reporting any current illness, injury, or impairment.

4) *Detailed information on illnesses, injuries, or impairments*: information on precise character of illness, medical care received, amount of disability, bed disability, work or school days lost, and so on.

5) *Hospitalization probe questions*: questions to aid respondent's memory in reporting episodes of hospitalization.

6) *Detailed information on hospitalization*: information on hospital admission, reason for admission, operations performed, name of hospital, and so on.

7) *Accidents and injuries*: date and class of event leading to injury, and so on.

8) *Medical care*: utilization of services of physician, place of visit, type of service, and so on.

9) *Dental care*: utilization of dental services, type of service, and so on.

The sample plan for the Household Interview Health Survey is designed in accordance with certain general specifications for sampling accuracy for national totals and for tabulations for various regional areas. The design is a complicated multistage plan, the main elements of which can be described in a few words by omitting procedural details. The plan follows in many respects that previously developed by the Bureau of the Census for its Current Population Survey. Initially, the 3103 counties and independent cities of the United States were grouped into about 1900 "primary sampling units" in a manner to form units of a single county or a group of contiguous counties of maximum internal heterogeneity and such that they

Table 1. Size of sample in different categories on which surveys covering different time periods are based.

Category	Period covered by survey		
	1 year	1 quarter	1 week
Persons	115,000	29,000	2,2
Households	36,000	9,000	7
Segments	6,000	1,500	1
Primary sampling units	372	372	~

could be covered efficiently by a single interviewer. These 1900 sampling units were then classified into 372 strata, as required by the tabulating specifications and according to a number of factors including the rate of population growth between 1940 and 1950, degree of urbanization, principal type of industry, type of farming, and various demographic characteristics. From each of these 372 strata a single sampling unit was selected with probability proportionate to its 1950 population. These 372 sampling units form the first stage of the multistage sampling design used for the Household Survey; they are scattered throughout the United States, with at least one unit in every state.

Within each primary sampling unit the ultimate stage sampling units, called "segments," are identified geographically in such a manner that each segment contains an expected six households in the sample. Each week a random sample of about 120 segments is drawn, and the approximately 700 households, containing approximately 2200 persons, included in these segments are interviewed. The continuing collection of information is consequently based on samples of the sizes shown in Table 1 for different time periods.

Each statistic produced by the survey —for example, the number of persons with one or more bed-days of disability in a specified period—is the result of two stages of ratio estimation. In the first of these, the ratio factor is 1950 decennial population count to estimated population for 1950 for the first-stage sample of primary sampling units. These factors are applied for 132 color-residence classes.

Later, ratios of the sample-produced national estimates of the population to official Bureau of the Census figures for current population in 76 age-sex-color classes are computed and serve as second-stage factors for ratio estimating.

The effect of the ratio-estimating procedure is to make the sample more closely representative of the population by age, race, color, and residence, thus reducing sampling variance.

As noted, each week's sample represents the population living during that week and characteristics of that population. Consolidation of samples over a time period, say a calendar quarter, produces estimates of average characteristics for the United States population for that calendar quarter.

Flexibility of Operation

The sample plan and the questionnaire scheme make possible a flexibility of operation in several respects. The continuous character of the data collection allows flexibility with regard to content, since the plan permits either a major change in the main questionnaire content at any time or a gradual evaluation of its content or technique. The survey can thus be made responsive to changing areas of health interest and can be technically improved as survey methodology is gradually perfected. In addition, the questionnaire plan permits the addition of a series of *ad hoc* supplements to the basic questionnaire to provide relatively quick answers on types of questions which require no more than one or two quarters of information for adequately accurate answers.

Flexibility can be obtained also in another respect—namely, with regard to time. The continuous succession of small weekly representative samples permits annual estimates for certain variables and relationships, quarterly estimates for statistics requiring less detail in tabulation, and even weekly estimates for certain totals where the frequencies are sufficiently high. The plan was not designed primarily for the making of such weekly estimates, but the recent influenza epidemic provided an opportune instance of the value of the survey in providing a current measure of the extent of disability from acute upper respiratory diseases.

Figure 1 (*8*) shows the two series of data relating to all acute upper respiratory diseases involving at least one day of bed disability. One series gives the weekly number of new cases of acute upper respiratory diseases (including influenza, pneumonia, and other similar conditions) involving one or more days of bed disability. The other series shows the average number of persons in bed each day of the week because of these diseases.

Series such as these not only give a consistent national index of the level and trend of certain medical conditions but, in this case, gave a more adequate measure for the first time of the total significance to the economy of the country of what may be, individually, relatively minor illnesses. For example, during the four-month period September–December 1957, there were an estimated 100 million new cases of acute upper respiratory disease involving at least one day in bed. The number of different people involved was somewhat less, since during this period many persons had more than one case. Some measure of the total impact of these diseases during the four-month period is given by the estimate that they involved a total of 357 million person-days of bed disability. As it proceeds, the household survey will bring to light many such facts, which will provide new perspectives on the health of the nation.

Publication Plan

The publication plan for the Survey is designed for releasing data on each different topic as soon as sufficient data are accumulated. It is not intended that material will be held until a comprehensive, but necessarily delayed, general report is compiled. Under the plan, several series of topical reports are to be issued under the general title "Health Statistics—from the U.S. National Health Survey." Series A of these reports will deal primarily with methodological studies and will present information on the procedures used in the various surveys and technical evaluations of the information compiled. Series B will consist of reports presenting, topic by topic, the substantive results of the surveys. Major issues of Series B will be based on data collected during the first full year of the survey—namely, July 1957–June 1958. However, a number of preliminary reports are now being prepared relating to data for the first quarter (July–September 1957) or for material for the first two quarters (July–December 1957). The first of these preliminary reports (*9*) presents statistics on the volume of physician visits, by sex and age of patient, by urban-rural residence, by place of visit, and by type of service given. Data are also given, for the population of the United States, on the time interval since a physician was last consulted. Other preliminary reports now in preparation cover dental services, persons injured, hospitalization, acute conditions, and disability.

When sufficient data have been accumulated by the Household Interview

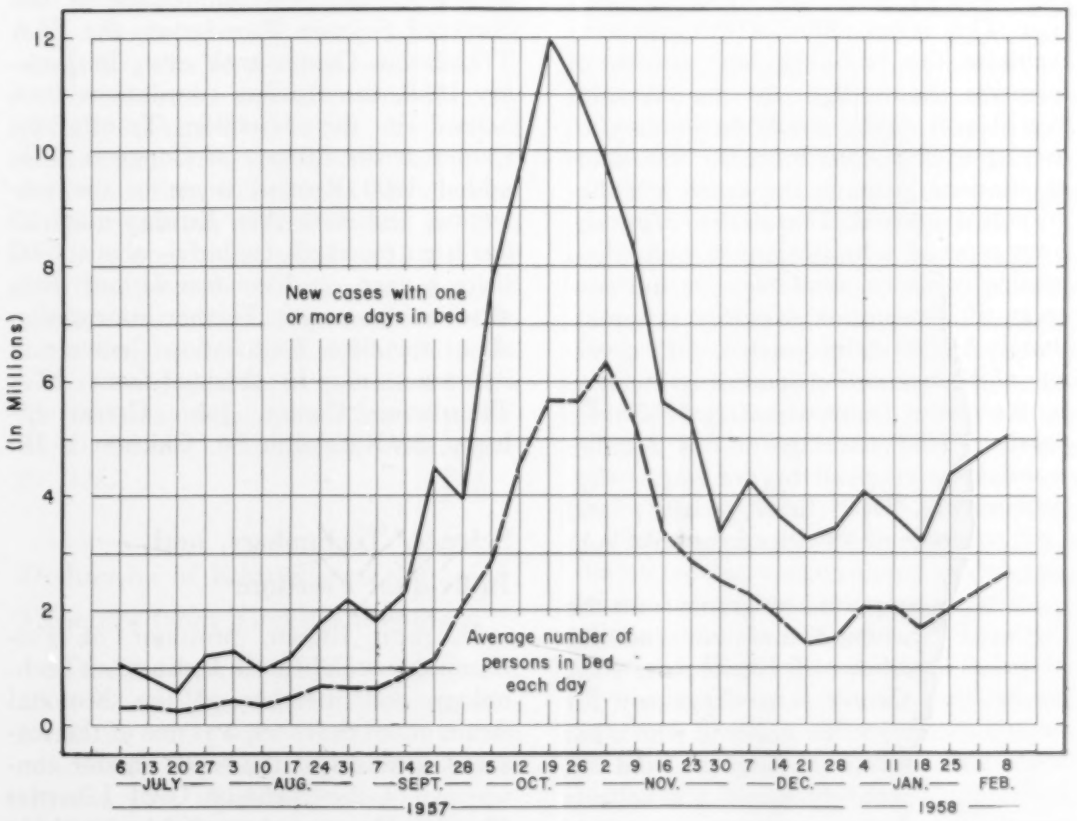

Fig. 1. Weekly estimates of the number of new cases involving one or more days of bed disability and the average number of persons in bed each day because of acute upper respiratory diseases, including influenza, pneumonia, and other similar conditions, in the United States, 6 July 1957–8 February 1958.

Health Survey, additional reports covering these and other topics will be prepared. These reports will give a wealth of new, detailed information relating these health items to various demographic and social variables. In a similar manner, the Health Examination Survey and other special surveys and studies will provide data for future tabulations, which will be published, topic by topic, when available.

References and Notes

1. Authorization for establishment of the U.S. National Health Survey was provided by the National Health Survey Act, Public Law 652, of the 84th Congress.
2. "Voluntary Health Insurance and Medical Care Costs, 1948–56," *Social Security Bull.* (Social Security Administration, December 1957).
3. "Measurement of Levels of Health," *World Health Organization Tech. Rept. Ser. No. 137* (Geneva, Switzerland, 1957).
4. *World Health Organization Tech. Rept. Ser. No. 53, 3rd Rept. of Expert Committee on Health Statistics* (Geneva, Switzerland, 1952).
5. "The National Health Survey 1935–36," *Public Health Bibliography Ser.* No. 5 (Federal Security Agency, Washington, D.C., 1951).
6. "The Survey of Sickness 1943 to 1952," *Studies on Medical and Population Subjects No.* (General Register Office, London, 1957).
7. A regular program of reinterviews is a part of the plan, but these reinterviews are for control purposes and for the investigation of methodological questions.
8. These data have been published in a series of weekly reports: *Provisional Tabulations from the U.S. National Health Survey, Reports 1–18.*
9. "Preliminary Report on Volume of Physicians' Visits, July–Sept. 1957," *Health Statistics B-1* (U.S. National Health Survey, February 1958).

News of Science

Translation Service Started by Special Libraries Center

The Special Libraries Association Translation Center, located at the John Crerar Library in Chicago, has announced that it can now furnish, on a subscription basis, printed catalog cards for current scientific and technical material which has been translated into English from all languages, including Russian. This latest effort of the center to facilitate the exchange and growth of scientific knowledge in the Western World will make available in easy-to-use, up-to-date card form the thousands of citations given in the center's bibliographical journal, *Translation Monthly.* Four types of subscriptions to translation catalog cards are available: (i) full coverage of *Translation Monthly* (approximately 12,000 titles yearly); (ii) coverage of all translations currently received by the center (approximately 6750 titles yearly); (iii) coverage of all Russian translations received by the center (approximately 3100 titles yearly); and (iv) coverage of all titles in specific subject fields.

Partially supported by grants from the National Science Foundation and the National Institutes of Health, the SLA Translation Center is a depository for unpublished scientific material which has been translated into English from all languages. It actively solicits and collects translations from government agencies, industry, technical societies, and educational institutions and makes copies of these translations available to other research groups and individuals. Users may borrow paper copies of desired translations or may purchase for permanent retention microfilms or photoprints of translations.

The SLA Translation Center was established at the John Crerar Library in October 1953. In less than 5 years the original collection of 932 translations has increased to more than 20,000 items, and approximately 6750 titles are being added annually. At the request of the National Science Foundation, the SLA Translation Center took over, in January 1958, the Russian translations then housed in the Scientific Translations Center at the Library of Congress. This added 4000 Russian items to the collection, and since then Russian material has been received regularly—about 3000 titles a year—as have translations from all other languages. Further information about the SLA Translation Center and its services may be obtained from: SLA Translation Center, John Crerar Library, 86 Randolph St., Chicago 1, Ill.

Science, Technology, and Individual Freedom

Harrison Brown, professor of geochemistry at California Institute of Technology and member of the National Academy of Sciences, was one of the featured speakers at the tenth annual conference of the National Civil Liberties Clearing House that was held recently in Washington. In his talk on "Science, Technology and Individual Freedom," he discussed both the necessity of individual freedom if science and scientists are to develop their full potential and the effects that science and technology are having on individual freedom. He cited three constraints that present-day society has placed upon the scientist's freedom. One is the sources from which the researcher receives his funds. The second "stems from the fact that scientists are individualists. They cannot work to best advantage in an atmosphere which is filled with FBI investigations, loyalty checks, loyalty oaths, public condemnation of their fellow-scientists, pressures for conformity, and accusations such as those which have been aired from time to time by both state and national investigating committees of various sorts."

The third constraint "involves communication, which is the lifeblood of inquiry." The major factors inhibiting the free exchange of ideas among scientists today are the classification for security reasons of scientific work and the restrictions placed upon their movements. Classification, Brown declared, "greatly impedes work, and in this respect it actually lessens our security." The difficulty some scientists have had in obtaining passports is part of the communications problem. More serious are "our formidable restrictions" on scientists abroad in security visas for entrance to this country, with the result that "most international conferences of scientists are held abroad." Brown stressed the dangers implicit in our increasingly industrialized society and the need for recognizing and avoiding them.

"As our population grows, as our reserves of high-grade raw materials diminish in abundance, we will be faced with the necessity of bringing ever-higher levels of organization into our lives. There will be less living space and less opportunity for movement. There will be cries for more efficiency. . . . It is amply clear that man can in principle create a wonderful world—a world in which people can lead free and abundant lives. But I fear that so powerful are the forces which operate in favor of increased organization and integration that we ourselves may drift into a form of totalitarianism

…thout realizing it. We can, if we don't …ch ourselves, permit our country to …ome a glorified ant hill. I do not, …ever, believe that this end result is …vitable. And here I take refuge in a …tement which was once made by the …at Disraeli. 'Circumstances,' he said, …e beyond the control of man. But his …nduct is in his own power.' "

Cerebrovascular Disease

The U.S. Public Health Service has …nounced that all known types of cere… strokes have been classified and de… for the first time in a study which …vides a common language for the ex…ange of information among research… throughout the nation. This pioneer… classification of cerebrovascular dis…es appears in the May issue of *Neu…ogy*, published in Minneapolis for the …erican Academy of Neurology.

The eight-member committee that con…cted the study was appointed by the …tional Institute of Neurological Dis…es and Blindness to explore means of …reasing research progress in cerebro…scular diseases. Clark H. Millikan, neu…logist of the Mayo Clinic, Rochester, … the committee chairman. He empha…es that the 2-year study is a first at…mpt, and many statements will undergo …anges as understanding of cerebrovas…lar disease increases. Copies of the …dy, *A Classification and Outline of …rebrovascular Diseases*, may be ob…ined from the National Institute of …eurological Diseases and Blindness, …thesda 14, Md.

NSF Grant to Yale to Improve Mathematics Instruction

The National Science Foundation has …arded $100,000 to Yale University to …itiate the work of the School Mathe…atics Study Group to improve instruc…on in mathematics in United States …condary schools above the sixth grade, …cluding junior high schools. The study …oup will consider: preparation of text…ook materials, together with teacher's …anuals; the training of teachers in the …e of such new materials; preparation … monographs designed for better stu…ents, secondary-school teachers, and the …neral educated public; various kinds of …aching aids, including films; experi…ental programs for gifted children; and …ychological studies of concept forma…on in mathematics and of attitudes to…ard mathematics, and the like.

The study group, consisting of sec…ndary school teachers and outstanding …iversity mathematicians, will be under …e direction of E. G. Begle, of Yale's …athematics department. An interim ad…visory committee to assist Begle consists of the following: A. A. Albert, University of Chicago; R. L. Wilder, University of Michigan, and S. S. Wilks, Princeton University. An expanded advisory committee will be established by the presidents of the American Mathematical Society, the Mathematical Association of America, and the National Council of Teachers of Mathematics.

As its first activity, the study group is organizing a 4-week session at Yale, 23 June to 29 July, at which college and university mathematicians and high-school teachers, in equal numbers, about 40 in all, will be asked to prepare detailed syllabi for high-school algebra and geometry courses. The study group will cooperate with such organizations as the Commission on Mathematics and the Curriculum Committee of the National Council of Teachers of Mathematics, which have already made large contributions in this area.

In-Service Institutes for High School Teachers

Approximately 3000 high school teachers of science and mathematics will benefit during 1958–59 from 85 in-service teacher-training institutes conducted by United States colleges and universities. The National Science Foundation has announced that grants totaling $607,250 have been awarded to support these institutes. The funds cover travel expenses, tuition, and fees. Participants in the program must be on the faculties of high schools that are within a radius of about 50 miles of the host institution.

The in-service institutes will offer especially designed work in the subject matter of science and mathematics. Institute meetings will be held outside regularly scheduled school hours so that teachers may attend while still teaching full time in their schools. Inquiries and applications for participation should be addressed to the directors of the individual institutes; these are named in a list that may be obtained from the National Science Foundation, Washington 25, D.C.

Deduction of Educational Expenses from Taxable Income

Many teachers in the United States at all levels—college, high school, and elementary—who have incurred certain educational expenses may be able to recover a part of their income tax payments for the years going back as far as 1955 as the result of U.S. Treasury Regulation TD 6291 announced on 4 April and published in the Federal Register for 5 April. In submitting an amended return, the taxpayer must use the appropriate income tax form for the year's return which is to be amended. He must write at the top of page 1, "Amended," and must resubmit the return in complete detail. While many aspects of the new ruling remain to be interpreted by the Treasury, the text as it appears in the Federal Register offers nine specific cases as examples.

Experimental Program in Secondary School Science Education

Starting in December 1955, the Research Corporation, New York, undertook an experiment concerned with the teaching of science at the secondary-school level in the state of Connecticut. While the experiment as originally designed is not yet complete, a report on the project to date provides some information that may be of value to those concerned with plans for the betterment of education.

A 3-year program has been established to learn from science teachers themselves their requirements for improving their teaching activities. Under the experimental plan, a representative visits schools throughout the state asking each science teacher what he or she needs to teach more effectively.

The teacher is encouraged to apply for a Research Corporation grant to satisfy his needs. Purposely, no application form is provided, and no particular limitations are specified about the kinds of things for which a grant might be considered or the level in funds that might be appropriate. The teacher's application is expected to take the form of a statement outlining the current situation in science at his school and indicating the improvements that would be possible with the funds requested.

Preparation of such a statement requires a certain amount of self-evaluation and considerable analytical thought. Frequently composing the statement sets off a chain reaction. Starting with an individual teacher, it often involves other science teachers at the school and their administrative superiors, sometimes even including the local board of education.

The program moves slowly. The foundation is at present receiving applications which had their origin in the stimuli applied to teachers a year or more ago. However, meanwhile the attention of individuals, groups, and even communities has been brought to bear constructively on what was needed to improve science teaching in a given school or school system.

In the 2 years that the plan has been in operation, total costs, including all fees and expenses, have amounted to a little less than $20,000. Forty-eight grants have

been awarded, amounting to about $50,000. It seems reasonably clear even now that the program has had a profound effect in the state of Connecticut.

News Briefs

The American Tobacco Company Research Laboratory in Richmond, Va., has received the Virginia Academy of Science's Distinguished Service Award as "International Leader in Tobacco Research, Befriender of Science in Community Affairs, and Outstanding Contributor to the Advancement of Science in America."

* * *

A bull whip cracks because its tip breaks the sound barrier, according to Horace M. Trent of the Naval Research Laboratory in a paper delivered at the recent meeting of the Acoustical Society of America.

* * *

A grant of $1,560,000 to finance basic research in natural and physical science has been allocated by the Eugene Higgins Scientific Trust. The money will be distributed in equal shares to Columbia, Yale, Princeton, and Harvard universities. Some $11,220,000 has been distributed for this purpose since the trust was established in 1948.

* * *

A special symposium on catalysis was held in honor of the late Vasili I. Komarewsky on 17 May at Armour Research Foundation of Illinois Institute of Technology, Chicago. Komarewsky, who died last June, was professor of chemical engineering at the institute, a consultant to Armour Research Foundation, and a founder of the Chicago Catalysis Club, which cosponsored the event.

* * *

The National Psoriasis Research Association is a new nonprofit organization whose purpose is to raise funds to finance research in psoriasis. Membership is open to all persons afflicted with this skin disease and to everyone who is interested in the work of the association. The association will make grants to the medical profession and to research laboratories on the recommendation of a medical advisory board. For information, write to the association at 161 Rockridge Rd., San Carlos, Calif.

* * *

The new Hall of North American Forests at The American Museum of Natural History has been opened to the public after 10 years of preparation.

* * *

The American Association of University Professors recently presented its first Alexander Meiklejohn award for service to academic freedom to the president and trustees of the University of New Hampshire. Eldon L. Johnson, president, and the trustees were cited for permitting Paul M. Sweezy, an editor-lecturer, to address students at the university in the spring of 1956. At that time Sweezy was free on bail after having been convicted of contempt of court by the Supreme Court of New Hampshire. The United States Supreme Court reversed the conviction last June.

* * *

Representative Melvin Price (D–Ill.) chairman of the Research and Development Subcommittee, Joint Committee on Atomic Energy, has announced that the subcommittee's hearings on employee radiation hazards and workmen's compensation, originally planned for the middle of June, will be postponed until early in the next session of Congress. Price also stated that he is asking the Atomic Energy Commission to submit a report on the subject to the Joint Committee by 1 January 1959; this report will serve as the basis of discussions at the hearings next session.

* * *

An agreement has been concluded between Poland and Denmark for a telephone and telegraph cable across the floor of the Baltic Sea. The cable will be the common property of the two countries and will handle the increased telecommunications traffic between Poland, Scandinavia, and Britain. It is expected that the laying of the cable will be completed by early 1960.

* * *

A postdoctoral fellowship for advanced study in biophysics is being established as a memorial to Robert Bruce Withrow, chief of the Division of Radiation and Organisms of the Smithsonian Institution. A pioneer in the biophysics of radiation, it was his hope to encourage research in this field by this means. Contributions may be addressed to Dr. Frederick S. Brackett, National Institutes of Health, LPB-NIAMD, Room B-4, Building 2, Bethesda 14, Md.

Proposed Legislation

HR 11950. Amend National Science Foundation Act of 1950 to encourage the training of additional engineers and scientists and expansion of facilities for engineering and scientific education by providing scholarships and fellowships for engineering and science students. Teague (D-Texas). House Interstate and Foreign Commerce.

HR 11960. Strengthen the national security, advance the cause of peace, and assure the pre-eminence of the U.S., in the academic, scientific, and technical disciplines through programs designed to stimulate the development and to increase the number of students of all educational levels in our schools, and provide additional facilities there- Knutson (D-Minn.). House Educati and Labor.

HR 11913. Amend the Public Hea Service Act to authorize grants for search and teaching facilities for existi and new medical, dental, and pub health schools; extend title VII of th act (re health research facilities) for additional 3-year period. Roberts (D Ala.). House Interstate and Forei Commerce.

S 3609. Provide for research into pro lems of flight within and outside th earth's atmosphere. Johnson (D-Texas Bridges (R-N.H.). Special Committ on Space and Astronautics.

Scientists in the News

J. E. P. L. VIGOUREUX, senio principal scientific officer of the Nationa Physical Laboratory, Teddington, Eng land, will attend a conference on ele tronic standards and measurements a the National Bureau of Standards Lab ratories at Boulder, Colo., 13–15 August

Three representatives of the Inter national Union of Physiological Sciences an affiliate of the World Health Organi zation, are visiting South American med ical schools and research facilities to discuss problems of medical educati and research. The group includes: CARL F. SCHMIDT, professor and chairma of the department of pharmacology at the University of Pennsylvania; C. HEY MANS, professor of pharmacology at th University of Ghent, Belgium; and R GRANIT, professor of physiology at th Karolinska Institute, Stockholm, Swede

FRANCIS HEMMING, who has held the office of honorary secretary to the International Commission on Zoological Nomenclature since 1936, has retired be cause of ill health. R. V. MELVILLE, a senior member of the paleontological staff of the Geological Society, London, has been released for a period of 1 year to take immediate charge of the office of the commission with the title of as sistant secretary to, and director of the office of, the International Commission on Zoological Nomenclature.

The New York Zoological Park has announced the appointment of JAMES A. OLIVER as assistant director and CHARLES P. GANDAL as veterinar ian. Both appointments stem from the departure of LEONARD J. GOSS, as sistant director and veterinarian, who as sumed the directorship of the Clevelan

on 15 May. Oliver has been curator of reptiles at the Bronx Zoo since 1951, and Gandal joined the zoo in 1952 as assistant veterinarian.

EARL INGERSON, former chief of the petrology and geochemistry branch of the U.S. Geological Survey, will join the staff of the University of Texas as professor of geology in September 1958.

CHARLES J. MERDINGER, commander, Civil Engineer Corps, U.S. Army, received the Toulmin Medal for a series of three articles entitled "Canals through the Ages," a history of canals from 3200 B.C.

MAX MYERS, director of the agricultural experiment station at South Dakota State College, has been named administrator of the U.S. Department of Agriculture's Foreign Agricultural Service—effective 1 July. He succeeds WYNN GARNETT, administrator since early 1955, who has resigned to take a post with Pan American World Airways.

VAL W. WOODWARD, associate professor in the department of agronomy, Kansas State College, has been named professor and chairman of the department of biology at the University of Wichita, Wichita, Kansas. The department of biology is a new department at the University of Wichita, being a merger of the departments of zoology, botany, and bacteriology. ALVIN SARACHEK, of the Institute of Microbiology, Rutgers University, will also join the Wichita biology staff on 1 July.

M. R. POLLOCK of the department of bacterial physiology of the National Institute for Medical Research, London, is visiting the Laboratory of Cellular Pharmacology, National Institute of Mental Health, Bethesda, Md., until 11 June. He is giving a short course of lectures on "Specific control of enzyme formation and its possible function in the development, adaptation and evolution of living organisms."

Retirement furlough will begin this summer and fall for a number of scientists at the University of Michigan. Those scheduled to begin furlough this June and their years of service are: BRADLEY M. PATTEN, professor of anatomy and chairman of the department of anatomy, 22 years; JOHN C. BRIER, professor of chemical engineering, 38 years; LEO L. CARRICK, professor of chemical engineering, 13 years; ELIZABETH C. CROSBY, professor of anatomy, 38 years; FELIX G. GUSTAFSON, professor of botany, 38 years; RUSSELL C. HUSSEY, professor of geology, 13 years; HUGH E. KEELER, professor of mechanical engineering, 42 years; WALTER E. LAY, professor of mechanical engineering, 39 years; and ARTHUR E. WOODHEAD, associate professor of zoology, 34 years.

Retirement furlough marks the end of regular classroom work and research activities at the university. Faculty members receive their regular academic salary for 1 year during retirement furlough.

RUTH WANSTROM, professor of pathology, will begin full retirement, effective 30 June, without retirement furlough. CHARLES B. GORDY, professor of industrial engineering, will begin full retirement, also without furlough, on 1 September 1959.

Those who began their retirement furlough during academic 1957–58 include: WALDO ABBOTT, associate professor of speech; FREDERICK A. COLLER, professor of surgery; MAURICE W. SENSTIUS, associate professor of geology; LOUIS A. BAIER, chairman of the department of naval architecture and marine engineering; MARGARET BELL, professor of hygiene and physical education and physician in the Health Service; and THEOPHIL HILDEBRANDT, professor of mathematics and chairman of the department of mathematics.

R. RUGGLES GATES of Cambridge, Mass., is sailing shortly for England on the way to Australia for an expedition to study the aborigines. He plans also to see Melanesians in New Guinea and Maoris in New Zealand, returning across the Pacific via Samoa, Fiji, and Hawaii. Gates will give an address to the Anthropology Section of the Australian and New Zealand AAS in Adelaide at the end of August.

BERNARD SAPER, director of the counseling center and assistant professor of psychology at Northwestern University, has been appointed director of psychological services in the New York State Department of Mental Hygiene, effective 1 July. He succeeds ELAINE F. KINDER, who is leaving to devote full time at Rockland State Hospital to a follow-up study of topectomized schizophrenic patients and to completing a monograph on the personality and social development of infant chimpanzees.

PAUL M. GROSS, vice president of Duke University and president of the Oak Ridge Institute of Nuclear Studies, will become an Honorary Commander of the Civil Division of the Order of the British Empire, as a result of a recent appointment by Her Majesty, Queen Elizabeth. The award is being made to Gross for "outstanding services to the cause of Anglo–American friendship and understanding." Gross served from 1953 until 1956 as chairman of the Southern Regional Marshall Scholarship Committee, which awarded scholarships to southern students for study in Britain.

JOHN H. VAUGHAN of the Medical College of Virginia will join the University of Rochester School of Medicine and Dentistry on 1 July to head a new section on immunology in the department of medicine. He has been appointed associate professor of medicine and assistant professor of bacteriology and immunology.

Recent Deaths

GLENN H. ALGIRE, Washington, D.C.; former medical director of the Laboratory of Biology, National Cancer Institute; 28 Apr.

MILES H. CUBSON, Philadelphia, Pa.; 61; educator and soil conservationist; was associated with the U.S. Department of Agriculture's Soil Conservation Service in Upper Darby, Pa.; author of *Soil Management for Greenskeepers*; 4 May.

EDMOUR F. GIGUERE, New York, N.Y.; 44; electronics consultant for the Radio Corporation of America; 6 May.

SAMUEL P. HAYES, Princeton, N.J.; 83; psychologist for the blind; professor of psychology at Mount Holyoke College from 1909 to 1940; from 1940 until 1954 director of teacher training and research at the Perkins Institution and Massachusetts School for the Blind in Watertown, Mass.; 7 May.

FRANK K. SHUTTLEWORTH, New York, N.Y.; 59; psychologist; professor in the department of student life at City College; author of a number of books and papers; 9 May.

J. FISHER STANFIELD, Oxford, Ohio; 57; chairman of the department of botany at Miami University since 1944; 7 May.

JOSIAH TURNER NEWCOMB, Port Washington, N.Y.; 54; assistant vice president of Gibbs & Hill, Inc., consulting engineers in New York; administered the design of steam, electric, and hydraulic facilities of the Savannah River Project for the Atomic Energy Commission; 6 May.

CORYDON M. WASSELL, Little Rock, Ark.; 74; physician; former medical missionary in China; 12 May.

Erratum: In the news article, "Atomic Clock Discrepancy" [*Science* **127**, 1107 (9 May 1957)], the values given for the accuracy and variation of the Atomichron are incorrect by a factor of 10. The possible accuracy of the Atomichron is 1 part in 10^{10}; the discrepancy between the American and British instruments is 9 parts in 10^{10}.

Book Reviews

Advances in Agronomy. vol. 9. A. G. Norman, Ed. Academic Press, New York, 1957. xi + 308 pp. $8.

This is the ninth volume in this series, all under the able editorship of A. G. Norman. This volume, like its predecessors, constitutes a valuable contribution to the literature in this highly varied field. In contrast to some of the series of "Advances" in other disciplines, *Advances in Agronomy* shows relatively little duplication in topics covered by successive volumes. A glance at the contents of this volume gives ample evidence of the reason for this policy. In a science encompassing the chemistry of zinc in soils along with defoliation and desiccation as harvest aids, a complete review of the annual progress of every segment of the field would not be possible in one book.

Like any other book with many different authors, this volume contains a wide variation in type of article, but in general the authors of the several chapters have written in scholarly fashion.

This volume contains the following chapters: "Agricultural trends in the old cotton belt," by R. W. Pearson and J. H. Yeager; "Zinc deficiency and its control," by Wynne Thorne; "Defoliation and desiccation: Harvest aid practices," by Frederick T. Addicott and Ruth S. Lynch; "The fixation of phosphorus by soils," by John B. Hemwall; "The lespedezas," by Paul R. Henson, Joe D. Baldridge, and Will A. Cope; "Measurement of soil bulk density and penetrability," by J. A. Vomocil; "The contribution of statistics to agronomy," by Oscar Kempthorne; "The residual effects of fertilizer," by R. L. Cook and J. F. Davis; and "The concept of braunerde (brown forest soil) in Europe and the United States," by R. Tavernier and G. D. Smith.

Thorne's chapter on zinc deficiency should be of great value to workers in areas where this problem is just being recognized. Foresters will find the article on the brown forest soils useful in any attempt to relate the European forestry literature to American experiences. The chapter on the lespedezas provides a valuable record of the current status of knowledge concerning this group of plants and also provides an excellent background for further management and breeding work with them.

While few agronomists will read this book from cover to cover, a great many will find one or more of its chapters of sufficient value to justify publication of the book.

W. H. Allaway
Agricultural Research Service, Beltsville, Maryland

Mechanical Resolution of Linguistic Problems. Andrew D. Booth, L. Brandwood, J. P. Cleave. Academic Press, New York; Butterworths, London, 1958. vii + 306 pp. Illus. $9.80.

This is the second book to appear in the relatively new field of mechanical translation. The first, *Machine Translation of Languages,* a book of essays edited by Locke and Booth, covered the subject as of three years ago. Since that time, more work has been done than during the preceding six to nine years; the number of abstracts appearing in the journal *Mechanical Translation* now stands at 121, and they numbered only 55 three years ago.

One should not expect to find in this book, however, a more up-to-date survey of the thinking on mechanical translation. It is, instead, a presentation of some of the work done in but one of a dozen or so groups around the world—that is, in the Birkbeck College (University of London) group under Booth, a pioneer in the field. The book does contain a historical introduction, but it is disappointing to discover that this starts with a rewritten and somewhat abbreviated version of the historical introduction of Locke and Booth, followed by three paragraphs on the subsequent work at Birkbeck College and only two paragraphs reporting some (but ignoring most) of the subsequent work done elsewhere. Besides mechanical translation, the book reports work in the fields of word counting, concordance making, and the statistical analysis of style, which [illegible] even less adequately treated than [illegible] earlier history.

The new work reported in chap[illegible] (presumably by Brandwood) on the [illegible] chanical translation of German [illegible] sents over half of the book and is [illegible] quired reading for all serious worke[illegible] the field. This work is entirely within [illegible] spirit of the early work of Oswald [illegible] Fletcher [*Mod. Language Forum* 3[illegible] (1951)], which is but one of the se[illegible] current approaches to the prob[illegible] of mechanical translation. Brandwo[illegible] work constitutes a careful examina[illegible] and criticism of the proposals of Os[illegible] and Fletcher, with a number of [illegible] suggestions for improvements and a[illegible] tions, but it does not pretend to [illegible] scheme for mechanical translation. P[illegible] haps the field has not yet advanced [illegible] enough for this.

The other, slightly smaller, half of [illegible] book consists of 11 chapters contain[illegible] work most of which has been publish[illegible] elsewhere. Early chapters present [illegible] mentary descriptions of punched-c[illegible] equipment and of Booth's compu[illegible] APEXC, and briefly explain how a co[illegible] puter may be used for counting words [illegible] for making concordances, both rath[illegible] easy to programme. A number of su[illegible] gestions appear on how a computer m[illegible] be used to examine texts and to compi[illegible] statistics that may be useful in decidi[illegible] for example, what is the chronologic[illegible] order of the *Dialogues* of Plato. Adequ[illegible] references to the literature are suppli[illegible] for the Plato problem. The descripti[illegible] of the Birkbeck approach to mechani[illegible] translation and how it may be pr[illegible] grammed brings together previously sc[illegible] tered material. A big point is made [illegible] the binary or "twenty questions" p[illegible] proach to table look-up routines—[illegible] approach that seems to have been co[illegible] mon practice among programmers [illegible] this side of the Atlantic as early as 195[illegible]

There is a chapter (probably [illegible] Cleave) on how to programme a co[illegible] puter to convert ordinary spelling int[illegible] the peculiar contractions of Braille, [illegible] chapter on French mechanical transla[illegible] tion (presumably by Brandwood), an[illegible] one which is a condensation of one [illegible] the reports from a group in Russia. A[illegible] cogent argument appears against the o[illegible] repeated suggestion that translating be[illegible] tween a number of languages be done [illegible] way of an artificial machine "interli[illegible] gua." The book ends with a descriptio[illegible] of a machine that, in theory, would b[illegible] better suited for mechanical translati[illegible] work than some of the existing ma[illegible] chines.

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…vances in Catalysis and Related Subjects, vol. IX. Proceedings of the International Congress on Catalysis, Philadelphia, Pennsylvania, 1956. Adalbert Farkas, Ed. Academic Press, New York, 1957. xviii + 847 pp. Illus. $16.

Every effort was made to get the world …ders in catalysis to participate in this …ference, and with marked success. Sir …gh Taylor, whose ideas on active …nts and activated adsorption have …ded research through the years, high…ts the past advances and looks to the …ure. It is particularly appropriate that … Eric Rideal should join again with …ylor in a common enterprise and dis… surfaces in the light of his wide ex…ience.

One hundred and forty-seven contrib…rs have prepared 83 papers for this …lume; these are presented in four ma… symposia. First, the "Chemistry and …ysics of Solid Catalysts" includes hy…genation and hydrogen exchange re…tions, physical properties of catalysts, …ctronic properties, and catalytic activ…. Next, "Homogeneous Catalysis and …lated Effects" is followed by "Surface …emistry and Its Relation to Catalysis." …ally, "Techniques and Technology of …talysis" includes consideration of cata…ic reactions of hydrocarbons, tracer …d other techniques, and various cata…ic reactions.

In a book where nearly every chapter … excellent, it is difficult to single out … high spots. Notable are the magnetic …dies by Selwood of structure and elec…n density in a functioning catalyst. …rkevich and his associates find a sharp …agnetic reasonance in a charcoal which …s been heated and then evacuated. De…er gives a useful discussion of the …ucture and texture of catalysts. Gar…'s discussion of electron transfer and …talysis reflects his wide experience. …ley takes an interesting look at mecha…sm, and Emmet surveys tracer and ad…rption techniques in catalysis. Houdry …ghlights the practical approach, while …hwab presents the modern solid-state …pect of catalysis. Every catalytic chem… will want to read this excellent book.

HENRY EYRING

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…almer's Fieldbook of Mammals. E. Laurence Palmer. Dutton, New York, 1957. 321 pp. $3.75.

By concentrating on mammals, Pal…er has been able to include in this …ocket-sized book a fuller coverage of …ative North American varieties than …s the case in his larger *Fieldbook of Natural History*. As before, however, the contents include wild types from this continent, pets and domesticated forms from the whole world, and a well-chosen selection of species popular in literature and zoos. About a third of the present book concerns domesticated and semi-domesticated mammals, with many helpful notes and a wealth of detailed information useful to farmer, housewife, parent, and junior naturalist.

Clear illustrations and specifications concerning geographic range, dental features, size and age and color range, breeding habits, growth rate, pulse, body temperature, and the like will be helpful to the technical zoologist, while notes on tracks and scats will aid the outdoor naturalist and conservationist.

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MARGERY MILNE

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Die Bluteiweisskoerper des Menschen. Untersuchungsmethoden und deren klinisch praktische Bedeutung. Ferdinand Wuhrmann and Charlie Wunderly. Schwabe, Basel, 1957 (order from Intercontinental Medical Book Corporation, New York). 499 pp. Illus. $13.

The new edition of this well-known textbook is, like the previous ones, divided into seven chapters. (i) "Chemistry of plasmaproteins" classifies the plasma proteins according to their electrophoretically separable components; discusses their chemical, physicochemical, and immunological properties, and treats the atypical proteins ("para-proteins") similarly. (ii) "Protein reactions" gives a selection of qualitative and quantitative methods for protein determination. (iii) "Test-methods" describes salt and alcohol fractionation, electrophoresis, and ultracentrifugation, with special emphasis on paper electrophoresis as a routine clinical method, and includes the new technique of immunoelectrophoresis. (iv) "Clinical-chemical methods" presents some laboratory tests for determining plasmaprotein alterations. (v) "Clinical significance of the plasmaproteins" classifies certain disease groups involving "para- and dys-proteinemias" into nine "*Reaktionskonstellationen.*" This is followed by a helpful reveiew of the relative values of the different laboratory methods and a thorough survey of the changes in blood proteins in specific diseases. A table summarizes, for purposes of differential diagnosis, the blood protein picture of obscure diseases. (vi) "Clinical considerations of dysproteinemias and paraproteinemias" deals with disease patterns resulting directly from severe and lasting changes in the different plasma protein components. The section on macroglobulinemia (Waldenstroem) has been considerably enlarged, while there are new sections on purpura hyperglobulinemia (Waldenstroem), gamma-globulin deficiency and the recently discovered analbuminemia (Bennhold). (vii) "Origin and formation of blood proteins" offers some speculations, mainly from the clinical point of view.

As the authors point out in their preface, no attempt is made to discuss hemoglobin, blood-clotting, and lipoproteins. Extensive references to the international literature are given throughout the book. The clinician will again welcome the schematic and lucid diagrams, which facilitate the recognition of the most important changes in each of the abnormalities discussed. Many of the terms, such as *para-* and *dys-proteinemia*, as well as some of the clinical laboratory methods, well known elsewhere, are not common in this country. This limits the value of the book to the American physician to some extent, and it will be interesting to see whether the English edition that has been announced will receive as wide an acclaim among clinicians here as the German edition has received in German-speaking countries.

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Science and the Creative Spirit. Essays on humanistic aspects of science. Karl V. Deutsch, F. E. L. Priestley, Harcourt Brown, and David Hawkins. Harcourt Brown, Ed. University of Toronto Press, Toronto, Canada, 1958. xxviii + 165 pp. $4.50.

The title of this collection of four essays by humanistic scholars is, as the editor confesses in his introduction, somewhat paradoxical and ambiguous. The difficulty lies in the subject, which cannot be labelled more precisely until it is better understood. Many scientists would maintain that science does have its humanistic aspects and would deplore the fact that only scientists, and perhaps few of them, can explain what these aspects are. Others would argue that the humanistic aspects of science, if it has any, are accidental and unintentional; accordingly the study of them might well be left to humanists who presumably have nothing better to do.

The history of science, which might have dealt with this field, has become a specialized discipline. The authors of these essays regard themselves as ama-

teurs and in a sense as pioneers, looking at science and its relations with other branches of knowledge sympathetically, and with more interest in learning than in judging or proclaiming. But what do they look at?

David Hawkins, author of the fourth essay, gives an answer: "The essential humanistic aspects of science are to be found, not in the method of science if there be such a thing, and not in the results of science as they appear in the text books, and not in the external influences of science on industry or on politics or on poetry or painting, but in the life of science as an expression of human capacities and limitations." To be sure, two of Hawkins' collaborators, F. E. L. Priestley and Harcourt Brown, both professors of literature, do survey wide areas of English and French literature for signs of interplay between scientific thought and imaginative works in various times and places. Karl Deutsch, in the first essay, tackles the formidable subject of "Scientific and humanistic knowledge in the growth of civilization," which includes industry, politics, technology, and the arts. But their several essays may be considered "converging statements" on the area specified by Hawkins.

The enterprise which resulted in this volume was conceived by Charles Odegaard and involved participation by a number of others over a period of five years. It is a good beginning.

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The Clinical Application of Antibiotics. M. E. Florey. vol. III, *Chloramphenicol and the Tetracyclines.* Oxford University Press, London, 1957. ix + 393 pp. Illus. + plates. $19.50.

This book is a sequel to the author's earlier work *The Application of Antibiotics: Penicillin,* published in 1952, and will shortly be followed by another volume dealing with more recently discovered antibiotics of proved clinical value. The author's announced aim is to furnish a critical evaluation of the data and to elucidate the general principles upon which the clinical use of antibiotics is founded.

Chloramphenicol and the three tetracyclines are discussed in separate sections under the following headings: "General considerations" (this includes origin, properties, complications of therapy, and so on), "The treatment of diseases due to specific organisms," and "The treatment of diseases considered by systems, age groups or sex."

For each antibiotic, laboratory data are included on in vitro sensitivity tests, antibacterial spectrum, animal trials, stability, and the levels obtained in blood and certain tissues by various routes of administration. Summaries of this material and illustrations and summaries of pertinent clinical data are presented in easily understood tables and charts. The coverage of toxicity studies and complications of therapy, in particular, is excellent.

In general, the earlier clinical reports on each antibiotic receive full treatment and critical analysis. Many later reports, regarded as containing confirmatory data, are omitted. Some of the clinical reports cited are of questionable validity, due to the use of noncritical diagnostic criteria by certain workers. It is understandable that in a work of this scope the author could not become sufficiently familiar with the reliability of each report to avoid such citations. In occasional instances, because of these two factors, a too optimistic view is presented of the effectiveness of these antibiotics in certain diseases.

In dealing with some diseases not currently presumed to respond to antibiotic therapy and with conditions due to mixed infections, or of unknown etiology, where citations of clinical trials are few, the author has refrained from critical comment. One not familiar with the subsequent clinical experience and current clinical views in these areas might be misled by this treatment.

Notwithstanding these few criticisms, the author has done a creditable job of sifting the fine from the dross. The result is a volume of immediate utility to, and deserving of a place on the bookshelf of, all scientists concerned with antibiotics and all clinicians who prescribe them. It should further serve as a useful reference work for years to come. The book is clearly written, well indexed, and notably free of typographical errors.

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Directory of Geological Material in North America. J. V. Howell and A. I. Levorsen. Revised with the assistance of Robert H. Dott and Jane W. Wilds. American Geological Institute, Washington, D.C., ed. 2, 1957. vi + 208 pp. $3.

The first 30 pages of this book list "Sources national and continental in scope," ranging from the Academy of Natural Sciences of Philadelphia to Fred S. Young of Oregon, who supplies diamond-saw blades. These listings carry brief explanations, not just addresses. The final 178 pages are entitled "Sources provincial and state in scope." Canada is covered in 19 pages, Central America in 1 page, Mexico in 1 page, the West Indies in 6 pages, territories of the United States in 6 pages, and the United States in 145 pages. Listings for these areas are given by province, state, or smaller region, and the contributor is given at the beginning of each section but, beyond, the name, not identified. It would increase the value of the directory if the contributors were identified and also if a current list of geologists, by province and state, were included.

This is a very handy book, 6¾ by 9½ inches. The information that it contains about where geological materials are available, who has well logs, where mineral collections are located, and so on make it a "must."

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New Books

Television in Science and Industry. V. K. Zworykin, E. G. Rambert, L. E. Flory. Wiley, New York; Chapman & Hall, London, 1958. 312 pp. $10.

The Story of Albert Einstein. The scientist who searched out the secrets of the universe. Mae Blacker Freeman. Random House, New York, 1958. 178 pp. $2.95.

Dr. W. C. Röntgen. Otto Glasser. Thomas, Springfield, Ill., ed. 2, 1958. 176 pp. $4.50.

The Chemical Industry in Europe. 4th report. Organisation for European Economic Co-operation, Paris, 1957. 199 pp. $3.

An Introduction to Experimental Surgical Studies. W. J. Dempster. Thomas, Springfield, Ill., 1957. 463 pp.

Encyclopedia of Chemical Reactions, vol. VII. Strontium, sulfur, tantalum, technetium, tellurium, terbium, thallium, thorium, thulium, tin, titanium. Compiled by C. A. Jacobson. Clifford A. Hampel, Ed. Reinhold, New York; Chapman & Hall, London, 1958. 486 pp. $12.75.

Chronic Schizophrenia. Thomas Freeman, John L. Cameron, Andrew McGhie. International Universities Press, New York, 1958. 168 pp. $4.

Handbuch der Physik. vol. XXXIV, pt. II, *Corpuscles and Radiation in Matter.* S. Flügge, Ed. Springer, Berlin, 1958. 324 pp. DM. 78.

Flora of the British Isles. pt. I, *Pteridophyta-Papilionaceae.* Drawings by Sybil J. Roles. Cambridge Univ. Press, New York, 1958. 144 pp. $5.

Chemical Calculations. A systematic presentation of the solution of type problems, with 1000 chemical problems arranged progressively according to lesson assignments. Bernard Jaffe. World Book, Yonkers-on-Hudson, N.Y., ed. 3, 1958. 192 pp.

Reports

Photochemical Activity of Digitonin Extracts of Chloroplasts

Digitonin, a nonionic detergent, has been used extensively to extract the photosensitive pigment-protein complex rhodopsin from the retinal rods of the eye. A light-dependent reaction, which is analogous to that occurring in the intact retina, can be measured spectrophotometrically with the extracted rhodopsin. This photochemical reaction "bleaches" rhodopsin and results in a shift of the absorption peak (from about 500 mμ to about 365 mμ). In the dark, rhodopsin is reformed, and this reaction is accompanied by a shift to the original absorption peak. Similarly, a photosynthetic pigment-protein complex, referred to as "chloroplastin" (*1, 2*), can be extracted by digitonin from plant chloroplasts, which appears to be homogeneous in the analytical ultracentrifuge and on electrophoresis. When chloroplastin is bleached by light, no shift in spectrum similar to that which occurs in the case of rhodopsin is observed. Chloroplastin bleaches at a rate proportional to the total amount of photo- and thermal energy absorbed, with a resultant steady decrease in optical density and with the disappearance of the maximum chlorophyll absorption peak at 675 mμ; it is bleached to unknown products (*3*).

Experimental attempts were made to promote with chloroplastin some photochemical reactions analogous to those of photosynthesis (*4*). The chloroplasts were isolated from *Euglena*, as has been previously described (*1*), and extracted with recrystallized, freshly prepared 2-percent aqueous digitonin (*5*) buffered at a *p*H of 8.4. Three different assay methods were used: assay by (i) the rate of photoreduction of the dye 2,6-dichlorobenzenoneindophenol, (ii) the evolution of oxyen, (iii) the conversion of inorganic phosphate.

The rate of photoreduction of the dye 2,6-dichlorobenzenoneindophenol ($3 \times 10^{-5}M$) was measured at 600 mμ (*6*) [after illumination for 1 to 4 minutes with 300 ft-ca (*7*)], 30°C, and a final *p*H of 7.1 ± 0.1 (0.1*M* phosphate buffer). In 20 percent of the preparations photoreduction of dye was complete within 2 minutes, with no accompanying reduction in darkness.

In those extracts of chloroplastin which exhibit active dye reduction, an absorption peak at 488 mμ of one of the *Euglena* carotenoids increases in optical density in the light and then decreases in the dark to its original density. This reaction can be repeated several times by placing the reactants alternately in light and darkness, without further addition of dye; this indicates that there is a reoxidation in the dark. Also this seems to indicate that there is an increase in the amount of carotenoid absorbing at 488 mμ simultaneously with the dye reduction. A cytochrome *c* photooxidase has been demonstrated in similar digitonin extracts by Nieman and Vennesland (*8*). In their experiments, cyanide was used to inhibit enzymatic dark oxidations; in ours, cyanide was not used.

Extracts yielding active photoreduction of dye were tested for their ability to cause photolysis or evolution of oxygen. Photolysis was measured manometrically in completely anaerobic Warburg vessels with KOH in the center well, and the dye was tipped from a side arm at zero time. The reaction conditions were the same as for dye reduction except that the system for photolysis measurements was made oxygen-free to permit a qualitative identification of oxygen evolved by bacterial bioluminescence. In some preparations of chloroplastin, photolysis occurred and yielded 20 to 30 μl of oxygen in 2 minutes, and there was a distinct luminescent glow, which persisted for almost a minute after an anaerobic suspension of *Photobacterium phosphoreum* in 3-percent NaCl-phosphate buffer was injected, in darkness, through a rubber serum-bottle stopper (*9*). Controls in the absence of light and others without dye did not evolve gas.

In the experiments in which photolysis occurred, a light-catalyzed conversion of inorganic phosphate into labile phosphate was observed over a 1-hour period in an anaerobic system similar to that described above, containing six cofactors and adenosine monophosphate. The reaction vessels contained 2 ml of chloroplastin (having a chlorophyll concentration of about $10^{-5}M$), 20 μmole of Mg^{++}, 30 μmole of α-ketoglutarate (*10*), 0.3 μmole of riboflavin-5-phosphate (*10*), 0.6 μmole of menadione (*10*), 2 μmole of ascorbate (*11*), about 5 μg of cytochrome *c* (*11*), 55 μmole of adenosine monophosphate (*10*), and 4 μg of inorganic phosphate, and the preparation was held at the same temperature, *p*H, and light intensity as in the procedures described above.

Inorganic and labile phosphate were measured by Fiske and Subbarow (*12*) and Crane and Lipmann (*13*) techniques. In one case, 700 μg of inorganic phosphate disappeared, but only 180 μg of labile phosphate could be found; in another, 550 μg of inorganic phosphate disappeared and 200 μg of labile phosphate was found. These experiments were immediately repeated with the addition of glucose and hexokinase (*10*) and the glucose-6-phosphate formed was determined by triphosphopyridine nucleotide (*10*) reduction at 340 mμ in the presence of glucose-6-phosphate dehydrogenase (*11*). In this way, 80 to 90 percent of the inorganic phosphate that disappeared was accounted for as labile phosphate. The phosphate conversion that occurred in the dark control was only 3 to 4 percent of that found in the light. Whether all of the cofactors play a role in this reaction is as yet not known.

We have made extensive efforts to prepare more uniform chloroplast extracts with digitonin and other detergents from isolated *Euglena* and spinach chloroplasts, but we have been unable to account, as yet, for the variability in activity from preparation to preparation. These results, though, indicate that some typical photosynthetic reactions can be observed with the digitonin extractable complex (the chloroplastin) from chloroplasts (*14, 15*).

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References and Notes

1. J. J. Wolken, *J. Cellular Comp. Physiol.* 48, No. 3, 349 (1956).
2. ——— and F. A. Schwertz, *Nature* 177, 136 (1956); chloroplastin is a digitonin extract of chloroplasts containing chlorophyll and carotenoids combined with proteins, lipids, and

All technical papers are published in this section. Manuscripts should be typed double-spaced and be submitted in duplicate. In length, they should be limited to the equivalent of 1200 words; this includes the space occupied by illustrative or tabular material, references and notes, and the author(s)' name(s) and affiliation(s). Illustrative material should be limited to one table *or* one figure. All explanatory notes, including acknowledgments and authorization for publication, and literature references are to be numbered consecutively, keyed into the text proper, and placed at the end of the article under the heading "References and Notes." For fuller details see "Suggestions to Contributors" in *Science* 125, 16 (4 Jan. 1957).

lipoproteins. *Euglena* chloroplastin appears to be similar to Smith and Youngs' chlorophyll holochrome.
3. J. J. Wolken and A. D. Mellon, *Biochim. et Biophys. Acta* **25**, 267 (1957).
4. D. I. Arnon *et al.*, *Proc. Intern. Congr. Biochem. 3rd Congr. Brussels, 1955* (1956), pp. 227–232.
5. The digitonin $C_{55}H_{90}O_{29}$–D-58 used in this study was procured from Fisher Scientific Co., Pittsburgh, Pa.
6. H. W. Milner *et al.*, *Arch. Biochem. Biophys.* **28**, 193 (1955).
7. General Electric 20-watt daylight fluorescent tubes were used.
8. R. H. Nieman and B. Vennesland, *Science* **125**, 353 (1957).
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10. The α-ketoglutarate, riboflavin-5-phosphate, menadione, adenosine monophosphate, hexokinase, and triphosphopyridine nucleotide used in this study were procured from Nutritional Biochemicals, Inc., Cleveland, Ohio.
11. The ascorbate, cytochrome *c*, and glucose-6-phosphate dehydrogenase used in this study were procured from General Biochemicals, Inc., Chagrin Falls, Ohio.
12. C. H. Fiske and Y. Subbarow, *J. Biol. Chem.* **66**, 375 (1925).
13. R. K. Crane and F. Lipmann, *ibid.* **201**, 235 (1953).
14. We thank Dr. Frank H. Johnson of Princeton University for providing the bioluminescent bacteria.
15. This study was aided in part by grants from the American Cancer Society (CP-69B), the U.S. Public Health Service [B-397(C3)], and the Stoner Mudge Foundation.
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31 December 1957

Gases in Glaciers

Gas trapped in the bubbles of glacier ice may originate from two different sources, depending on the manner in which the ice was formed. If the temperature is always below freezing in the area of ice formation, as in parts of Greenland and Antarctica, there is no melting, and the ice is formed simply by compaction of snow crystals. Air is trapped between the crystals, and the composition of the gas in such ice should be uniform and the same as that of the atmosphere (Table 1) at the time the ice was formed. If there are no losses or additions, it seems probable that the air will be preserved in its original state for the life of the ice.

If melting is involved in the formation of the ice, as in the case of the more temperate glaciers, the gas will have a different composition. Water equilibrated with air at 0°C contains 2.9 percent (by volume) of dissolved gases (Table 1). Since gas is insoluble in ice (*1*), the gas will separate from the water, on freezing, and will contribute to the gas content of the ice. Since meltwater is not evenly distributed in the firn, there will be variations in the composition of the gas enclosed in the ice thus formed.

Because the atmospheric gases dissolve in water in proportions that differ from their proportions in the air, it is possible to estimate the amount of water involved in formation of the ice (*2*). For this purpose the ratio of the inert gases—that is, the ratio of argon to nitrogen—is considered to be constant. Such an estimate gives, therefore, evidence about the climate at the time the ice was formed and, in theory, should also yield information about the composition of the atmosphere at that time.

The gas enclosed in a temperate glacier in Norway has been systematically examined (*3*). When the ice was formed, it contained a gas which was mostly air, with a small admixture of gas that had been separated from water by freezing. This was evident from the variations in composition from bubble to bubble and from elevated carbon dioxide values. However, during their life in the glacier, the oxygen, argon, and carbon dioxide components of the gas had been systematically removed. This was attributed to a leaching process which takes place during the warm summers of the temperate climate, when the temperature of the ice approaches 0°C and slight films of water containing dissolved gas may migrate through intercrystal boundaries.

In glaciers or icecaps where the temperature of the ice remains below zero, it would appear that the ice is an excellent preservative of the enclosed gas. Glacier ice is pure and comparable in salt content to distilled water (*4*), and there is not enough contaminating matter in the ice to produce a chemical reduction of the oxygen. Also, gas diffusion through ice is extremely slow—less than that of helium through glass (*5*)—and because of the enormous distances within a glacier it seems unlikely that the composition of the gas could change appreciably by diffusion through the ice, even over long periods of time.

It is well established that there have been climatic cycles since the last ice age, with temperatures warmer and colder than at present (*6*). The composition of the atmosphere has been known, through analysis, for only about 100 years, during which time the carbon dioxide content seemingly has not increased measurably (*7*). The theory has been postulated, though, that a high carbon dioxide content would result in a warm climate, through a "greenhouse" effect (*8*); this theory lends special interest to the study of the carbon dioxide content of the air.

Table 1. Composition of dry gas.

Component	Atmospheric air (% by volume)*	Water equilibrated with air at 0°C, 760 mm-Hg† (% by volume)
Nitrogen	78.09	61.54
Oxygen	20.94	34.90
Argon	0.94†	1.86
Carbon dioxide	0.03	1.75

* Data from R. J. Hock *et al.*, *J. Meteorol.* **9**, 441 (1952).
† Data from *Handbook of Chemistry and Physics* (ed. 36, 1954–55).

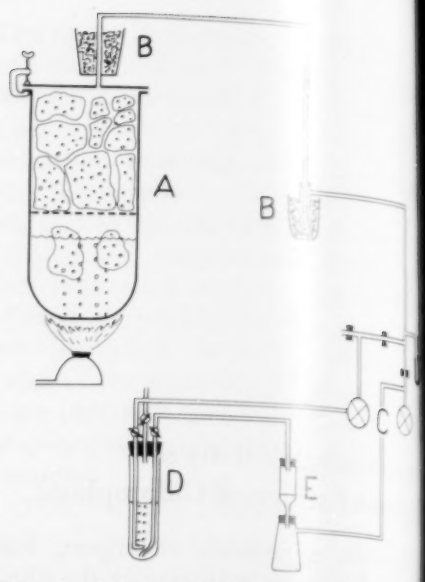

Fig. 1. Schematic diagram of equipment for extraction of carbon dioxide: *A*, 130-liter vacuum-tight ice-melting pot; *B*, vapor traps containing salt-snow mixture; *C*, high-vacuum pumps for taking vacuum and transporting the gas; *D*, barium hydroxide absorption tube; *E*, filtration unit for collecting and washing barium carbonate.

What was the climate and what was the composition of the atmosphere in ages past? Greenland and Antarctica are covered by large ice sheets, in which some of the ice may be 20,000 years old or more. It seems likely that analysis of the gas contained in this ancient ice may provide some answers to these questions.

Samples of glacier ice from three locations near Thule, northwest Greenland, have been collected and analyzed for enclosed gas (*2*). The amounts of oxygen, argon, and carbon dioxide in these samples were all equivalent to, or higher than, those of these gases in air and varied within each piece of ice. This indicated that the ice was formed in a period when the summers, at least, were warm in these latitudes. Using the ratio Ar/N_2, we calculated values for oxygen and carbon dioxide and compared these calculated values with the observed values. The oxygen content of the gas was close to that expected, but the values for carbon dioxide were scattered around a value twice as high as that for present-day air. One explanation might be that the composition of air was different with respect to carbon dioxide when this ice was formed.

Information thus obtained about ancient atmosphere and climate is of little value unless the age of the ice is known. When it was found that the carbon dioxide content of the Greenland ice sam-

...les was relatively high, a method was developed to extract and collect the carbon dioxide gas component from ice for radiocarbon dating. The technique was to melt the ice under vacuum and boil the meltwater, all the while removing the gas through a solution of barium hydroxide (Fig. 1).

This technique was tested during April 1957 on Storbreen, the Norwegian glacier examined previously. About 5000 kg of ice (approximately 50 "runs" of the extraction apparatus) were required to obtain enough C^{14} for a reasonably accurate count. Three weeks were required for mining and transporting the ice and for extracting the gas.

The resulting barium carbonate was taken to the Physical Laboratory at the University of Groningen for measurement of the age of the carbon dioxide (*9*). The age obtained for terminal Storbreen ice was 710 ± 120 years. Since only 03 g of carbon was available, the sample was counted twice during 5 days (*10*). The age is in excellent agreement with age estimates made by the Norwegian Polar Institute. It appears that this is a suitable technique for the dating of glacier ice.

In conclusion, glacier ice contains gases in sufficient quantity for accurate analysis. Present evidence indicates that, although changes may occur in the gas enclosed in temperate glaciers, the gas trapped in high-polar ice is well preserved. The composition of the enclosed gas yields information on the amount of meltwater that was present in the firnification process, and hence on the climate at the time the ice was formed.

Information on the composition of the atmosphere at the time of ice formation is also obtained. An investigation of gas in icebergs (*11*) showed one of the icebergs to have an absolutely uniform gas composition with respect to oxygen, indicating unchanged atmosphere. It would seem that, through further investigation in Greenland with the techniques now available, it may be possible to locate, analyze, and date ancient atmosphere in its original state.

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Sensitivity to Oxygen During Postembryonic Development of the Wasp Habrobracon

Work on the effects of oxygen gas upon *Habrobracon juglandis* (Ashmead) has shown that pupae are injured by exposure to oxygen whereas larvae appear to be unaffected (*1*). Pupae exposed to 30 lb of oxygen for 1 minute showed an immediate and marked decrease in oxygen uptake as well as arrested development. Since pupae and larvae differ considerably in their sensitivity to oxygen gas, it seemed pertinent to determine at what stage the change from oxygen-resistance to oxygen-sensitivity occurred. Since injury from exposure to oxygen in *Habrobracon* can be established by measuring the oxygen consumption or by determining the incidence of embryos that are able to develop to the adult stage (*1, 2*), we decided to study the stage-sensitivity to oxygen gas, using these criteria. In the present report the effects of exposure to oxygen upon the oxygen consumption at various stages of postembryonic development is reported (*3*).

The wasp *Habrobracon* is parasitic upon the larvae of the Mediterranean flour moth, *Ephestia kuhniella* (Zeller). Female wasps were placed in dishes containing *Ephestia* larvae and were permitted to lay eggs upon them. After a 2-hour period the wasps were transferred to other dishes containing fresh *Ephestia* larvae. Cultures were allowed to develop to the desired stage for treatment with oxygen (Table 1). The life-cycle from egg to imago takes about 8½ days at 31°C. The cultures used consisted entirely of haploid males and were obtained parthenogenetically from unmated mothers.

Individuals of known age and stage of development were placed in plastic chambers of approximately 100 cm^3 volume. Oxygen gas was flushed through the chamber for 1 minute in order to remove the air and was then applied for an additional minute at 30 lb pressure. The cultures were then removed from the chambers, flushed with air, placed in a flask, and measured for oxygen consumption about 1 hour after treatment, by means of the Warburg apparatus. Determinations were made on groups of 25 wasps for a 3-hour period. Measurement of oxygen consumption for an additional 3 hours showed no change from the first 3 hours. The oxygen-treated groups were paired with air-exposed control groups so that a measure of the degree of injury could be obtained by determining the ratio of oxygen consumed by experimentals to that consumed by the controls (see Table 1, column 5). Other individuals in the cultures were examined in order to determine whether the oxygen-treated embryos could develop to the adult stage.

The oxygen consumption for *Habrobracon* exposed to air or to 30 lbs of oxygen at certain stages of postembryonic development is presented in Table 1. Each value and standard error is based upon from three to six experiments. Comparison of the "oxygen consumed" values for experimentals and controls shows that for some stages of development there is no significant difference while for others the difference is large. Comparison of the values for magnitude of oxygen consumption, with age, for the controls shows the U-shaped curve that has been reported for many insects. Cultures that are oxygen-treated as larvae in cocoons or as prepupae show no decrease in oxygen consumption from that of their control groups. Furthermore, cultures at these stages were able to develop normally and to emerge as adults. Cultures consisting of a mixture of prepupae and white pupae show a significant difference in oxygen consumption between controls and experimentals. This difference is more pronounced for white pupae (120 hours and 144 hours old) and for pigmented pupae (168 hours old). The oldest pigmented pupae (192 hours) show a decrease in sensitivity (Table 1).

The decrease in oxygen consumption reported here for the oxygen-treated pupae is a permanent decrease. Experiments reported elsewhere (*2*) have shown that there is no subsequent increase in oxygen consumption for these pupae, even after 24 and 48 hours. The effect reported here is irreversible.

Wasps in these stages of development show not only a decrease in oxygen consumption after oxygen treatment but arrested development as well, so that most of these insects do not reach the adult stage. Exposure of white pupae to 30 lb of oxygen for 1 minute will cause over 95 percent of these wasps to remain as white pupae (*2*). This procedure is now

Table 1. Oxygen consumption of *Habrobracon* exposed to 30 lb of oxygen.

Age (hr)	Stage of development	Oxygen consumed/μl hr 25 wasps		Oxygen consumed (percentage of amt consumed by controls)
		Air-exposed controls	Oxygen-treated	
80	Larva in cocoon	98 ± 6	92 ± 2	94
96	Larva in cocoon	98 ± 5	97 ± 5	99
112	Prepupa	55 ± 3	56 ± 2	102
116	Prepupa and white pupa	58 ± 2	39 ± 4	67
120	White pupa	53 ± 3	24 ± 7	45
144	White pupa	42 ± 4	4 ± 1	10
168	Pigmented pupa	37 ± 1	10 ± 1	27
192	Pigmented pupa	62 ± 6	47 ± 4	76

used routinely in our laboratory in order to arrest the development of pupae so that they can be used for various physiological studies. Although both a decrease in oxygen consumption and arrested development result from exposure of pupae to 30 lb of oxygen, it is not clear at present in what way, if at all, these two types of injuries are related. It appears from these data that injury from exposure to oxygen occurs with the onset of the white pupal stage and that there is a greater oxygen-sensitivity in older white pupae and in younger pigmented pupae than in wasps in the other stages of development.

These studies show that individuals of *Habrobracon* in certain stages of development are injured by oxygen while those in other stages apparently are unaffected. The reason for this stage-influenced sensitivity is not known and is a point of interest in continuing investigation.

It seems clear, however, that this difference in sensitivity is not due simply to a difference in the rate of metabolism. Although larvae are more active and also more oxygen-resistant than pupae, pupae whose rate of metabolism has been lowered by exposure to lower temperature (10°C) are more oxygen-resistant than pupae whose rate of metabolism is higher due to exposure to temperature of 26°C before treatment with oxygen (*2*). It is commonly known that organisms are more sensitive to oxygen when in a higher metabolic state than when their metabolism has been lowered. Adults of *Drosophila azteca* whose metabolic rate had been raised by elevation in temperature were more sensitive to oxygen poisoning than flies of lower metabolism (*4*). In rats, the lowering of metabolism by removal of the adrenal cortex reduces oxygen sensitivity, while the injection of adrenal cortex extract into adrenalectomized rats increases their oxygen-sensitivity (*5*).

If some basic cellular process is involved, it seems probable that the difference in sensitivity between larvae and pupae would be of a quantitative nature but that both would be affected. Since pupae are injured but larvae or prepupae are not, it appears that some oxygen-sensitizing process occurs in the pupal stage but not in the larval or prepupal stages. A comparison of metabolism at these various stages of development is required to determine the processes involved.

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2 January 1958

Double Monochromation in Ultraviolet Microspectrophotometry

Ultraviolet microspectrophotometers include, besides a light source and a detector (photocell or multiplier), a monochromator and a suitable ultraviolet microscope. To avoid excessive irradiation of the object, the monochromator is usually placed between the light source and the microscope.

Several difficulties had to be met in constructing a workable microspectrophotometer. Chromaticity of the optical system, such as is encountered in Zeiss monochromats, has been overcome by the use of catoptric or catadioptric objectives, as in the systems designed by the American Optical Company and by Bausch & Lomb. Fluctuations of the light source that produce absorptions or transmissions not related to the object have been minimized, either by stabilizing the sources or by introducing double-beam systems. Nonlinearity of the detectors has been corrected by using null methods—for example, by inserting a rotating variable sector into the light beam passing through the microscope. What is the reading of the sector aperture which gives the transmissivity in the case, and the detectors monitor constant intensities only.

And yet, even arrangements employing all these features work well only if certain additional conditions are fulfilled. The apparatus ought to be used in a spectral region where the output of the lamp is high and the detector exhibits a high sensitivity to the incident signal. These restrictions are necessary because of the stray light present when a single monochromator is used. At the exit slit not only light of the "nominal" wavelength but also spurious scattered and reflected light, embracing the entire spectrum, is present. Such over-all random light may amount to several percent of the total radiation.

The random light results in a significant number of false readings in spectrophotometry and microspectrophotometry, especially when transmission measurements are made in a spectral region where there is little emission from the light source or when the response of the detector is weak, or when both these conditions exist. (It is immaterial whether this decrease in response is due to the characteristic of the sensitive surface of the detector or to a strong absorption in the optical train, including the envelope of the detector.) The situation is still further complicated if the specimen strongly absorbs at the nominal wavelength setting of the monochromator. Coincidence of some or of all of these factors listed necessarily results in serious errors when stray light, at or near the peak sensitivity of the detector, is not absorbed by the optical system, including the specimen and cell envelope. Under such circumstances Halban and Eisenbrand (*1*) recorded errors of up to 75 percent.

Hogness and his coworkers (*2*), Deck (*3*), Zscheile (*4*), Gibson (*5*), and others have established the conditions for precise spectrophotometry. Caspersson (*6*), Sinsheimer (*7*), and Walker and others (*8*) have established those of microspectrophotometry (see also Harrison *et al.*, *9*, and Kortüm, *10*). It is now generally acknowledged that double monochromation is essential for exact transmission measurements. If initially monochromatized light, containing 2 percent of stray light, is fed into a second

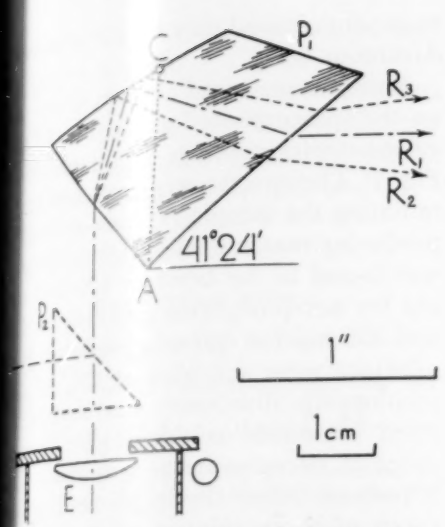

Fig. 1. Arrangement of a postmonochromatizing, right-angle deviation prism above the microscope. *O*, ocular; *E*, eye lens; P_1, quartz Pellin-Broca prism in position for wavelength of $\lambda = 253.6$ mμ; *C*, axis of rotation; *AC*, bisector; R_1, optical axis referred to the "nominal" wavelength; R_3, R_2, rays of longer and shorter wavelengths, respectively, which do not reach the sensitive cathode of the detector; P_2, auxiliary removable prism for visual observation through a willemite screen placed to the left of P_2.

identical monochromator, then one obtains light of 99.96 percent purity at the second exit slit.

At the University of Kansas Medical Center, a singly monochromatized double-beam microspectrophotometer, originally built by Wiseman (*11*) and Stowell (*12*), was converted into a doubly monochromatized one without extensive modification in the general layout of the instrument. The original instrument included a totally reflecting quartz prism mounted above the microscope, to direct the emerging light beam to the photomultiplier.

The necessary right-angled bend in the microscope beam can be obtained by use of a Pellin-Broca prism (*9*) that combines both the constant deviation of the 90° prism and the dispersive properties of a standard 60° prism. Rotating this Pellin-Broca prism about a particular axis brings radiation of any wavelength into the detector (Fig. 1).

Therefore, in our modifications, the original prism was replaced by a quartz prism after the method of Pellin and Broca. Because this was a double-beam system, the control beam, too, had to be doubly monochromatized. It is essential that the two prisms be as similar as possible and that they be rotated through exactly the same angle. To attain this objective, an aluminum angle, carrying both prisms, was mounted above the microscope. It was pivoted on either end, the pivot points representing the axis of rotation of the prisms. Also, the beam splitter was turned so that both the microscope and the control beam follow optical tracks which are parallel to each other.

To control the tilt of the two prisms, an attached lever was fitted with a ball-bearing follower that engaged a rotatable cam. This cam was so constructed that the graduation of the wavelength scale became linear. This arrangement facilitates the eventual coupling of the two monochromator controls.

As a result of these alterations, the control beam multiplier was raised to the level of the microscope beam detector. The two multipliers could thus be housed in a common, evacuable compartment. The wire lead feeding the multiplier outputs to the control grid of the first amplifier stage could thus be made of minimal length. This change made possible the elimination of occasional drifts of the microammeter, which could occur even when the multipliers were not exposed to light. It must be realized that a grounded metal cabinet containing a sufficiently charged lead is, in principle, nothing but an air-filled ionization chamber. The sporadic readings obtained when such a cabinet is used are evidently due to cosmic or other highly penetrating radiations. Deck (*3*) also reported such phenomena, and a number of workers demand evacuated compartments for photocells or multipliers, and for the first amplification stage as well.

The performance curve was taken according to specifications of the National Bureau of Standards (*13*). The measured transmittances of the K_2CrO_4 solution fit the standard curve to within 2 to 3 percent of the full-scale value except at the ends of the useful range (220 to 600 mμ), where the response of the multipliers drops to zero. In addition, toward shorter wavelengths, the transmission of the optical components diminishes because of the rapidly growing opacity of the quartz, the Vycor, and the Corning 9741 glass that makes up the envelopes of the multipliers (*14*).

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Interaction between Allithiamine and Metal Enzyme

It is well known that reducing substances such as sulfhydryl compounds convert "allithiamine," a derivative of vitamin B_1, into allyl disulfide and thiaminyl thiol, in vitro as well as in vivo (*1–4*). It has been pointed out recently by Honda (*4*) that ascorbic acid, although it is a strong reducing agent, does not reduce allithiamine.

The reducibility of allithiamine by sulfhydryl compounds has been made the basis for the microdetermination of sulfhydryl groups in the blood of metamorphosing insects (*5*). In the course of this study (*6*) it was found that melanin formation in the blood of silkworms, *Bombyx mori* and *Philosamia cynthia ricini*, was retarded remarkably in the presence of allithiamine. Melanin formation was markedly suppressed when 0.5 ml of the blood of pupating worms was mixed with 3 ml of phosphate buffer (*p*H 5.91) and with 1 ml of allithiamine (250 μg/ml) at room temperature, whereas it occurred immediately in the control in which allithiamine was replaced by distilled water or thiamine (250 μg/ml), as is shown in Fig. 1.

Measurement of oxygen uptake confirmed the visual observation that allithiamine suppresses melanin formation. The degree of retardation by allithiamine of melanin formation seems to correspond to the concentration of sulfhydryl groups in the blood (*5*).

It is known that melanin formation is inhibited by sulfhydryl compounds such as cysteine in vitro as well as in vivo (*7*). But this inhibition in the blood of the present materials was not so strong because melanin formation took place in the control. Therefore, the remarkable suppression of melanin formation observed in the present experiment may be due mainly to the formation of thiaminyl mercaptide by the reaction between cupric tyrosinase and the sulfhydryl group of thiaminyl thiol derived directly from allithiamine.

Coincident with the reduction of allithiamine, two substances will be pro-

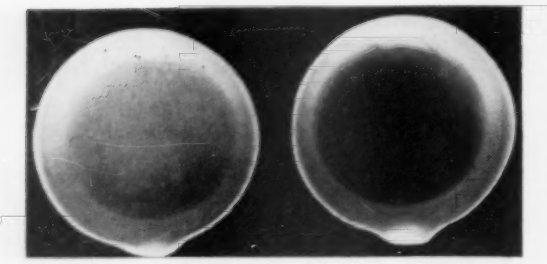

Fig. 1. Melanin formation in blood of *Philosamia cynthia ricini*. (Left) Retarded melanin formation by allithiamine; (right) normal melanin formation.

duced: allyl mercapto radical (CH_2=CH—CH_2—S·) and thiaminyl thiol [(B_1)—SH]. The former is well known to combine with sulfhydryl (SH) groups in vivo (*2, 4, 8*), so that it is probably the latter which will combine with cupric tyrosinase according to the following equation:

$$(B_1)\text{–S–S–}CH_2\text{–CH=}CH_2 + \text{R–SH} \xrightarrow{\text{(metal enzyme)}}$$

allithiamine; SH group in blood

$$\text{R–S–S–}CH_2\text{–CH=}CH_2 + \text{(Metal enzyme)–S–}(B_1)$$

allyl disulfide; thiaminyl mercaptide

This interpretation of the above results may be applicable to the reaction between allithiamine and other metal enzymes in vitro as well as in vivo (*9*).

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4 December 1957

Effect of Light on Fluorescence of Ethylenediamine Derivatives of Epinephrine and Norepinephrine

In 1953 Weil-Malherbe and Bone (*1*) described a procedure for the differential estimation of epinephrine and norepinephrine in mixtures. They found that, after incubation with ethylenediamine, the fluorescence of these two compounds differed enough so that at 500 mμ the ratio of the fluorescence of epinephrine to norepinephrine was 0.98 whereas at 550 mμ it was 4.4. The solutions appeared to be stable for 24 hours at room temperature under ordinary light conditions. Persky and Roston (*2*) published curves representing the emission spectra of these substances which were in substantial agreement with these findings.

Studies conducted by Aronow and Howard (*3*) and studies made in our own laboratory (*4*) suggested that entirely different ratios were obtained when the procedure was carried out in a room illuminated by red or orange light. The difference appeared to be due to changes in the intensity and distribution of the norepinephrine fluorescence. Crude experiments performed at that time indicated that about 80 percent of the fluorescence of the norepinephrine was lost if the reaction was carried out in daylight. When daylight was excluded, the ratio of epinephrine to norepinephrine at 485 mμ was approximately 0.2 and at wavelengths above 550 it was about 3.2, when light at a wavelength of 436 mμ was used to activate the solutions. The effect of blue light was also evidenced by the decay during activation at 436 mμ in the Farrand photoelectric fluorometer, as noted by Valk and Price (*5*) and Mangan and Mason (*6*).

Mangan and Mason (*6*) have recently published curves for the fluorescent products of the above reaction which differ from those of Persky and Roston (*2*). It is the purpose of this report (*7*) to suggest that the differences described may be related to quantitative or qualitative differences, or both, in the exposure to light and, furthermore, that the exclusion of blue and ultraviolet light results in an emission spectrum differing from the previously published findings.

Measurements were made with the Aminco-Bowman spectrophotofluorometer. In order to obtain the entire emission spectrum between 400 and 600 mμ without interference from scatter by the source of activating light, high concentrations of the amines were employed. However, experiments with the concentrations employed by Mangan and Mason produced similar results except for the presence of a significant blank at the lower concentrations.

Duplicate samples of epinephrine and norepinephrine (*8*) were prepared in alumina-treated acetic acid. One of the samples of each amine was incubated with ethylenediamine and ethylenediamine dihydrochloride for 40 minutes at 50°C. After saturation with sodium chloride, the solutions were extracted with isobutanol. The final extract contained the equivalent of 12 μg of epinephrine or norepinephrine per milliliter. The entire procedure was carried out in a room illuminated by daylight. The duplicates were carried through the same procedure in a room illuminated only by a 25-watt ruby darkroom lamp.

Samples were read at intervals of 5 mμ on the spectrophotofluorometer, and the galvanometer readings are illustrated in Fig. 1. The spectra were obtained by irradiating the samples at the wavelength producing maximum activation; this area was found to lie between 420 and 425 mμ for norepinephrine and between 430 and 435 mμ for epinephrine. When both solutions were activated at 436 mμ, the relationship illustrated was slightly altered inasmuch as the relative fluorescence of norepinephrine was reduced by 7 percent. After the initial reading was taken of those solutions that were prepared in the darkroom, the cuvettes were exposed to daylight for 5 minutes in order to reduce the fluorescence of the norepinephrine sample to approximately 50 percent. The results of these experiments are illustrated in Fig. 1.

In Fig. 1, the upper left-hand curves were obtained from the solutions carried through the procedure in the dark. The middle curves on the left were obtained by rereading the same solutions after exposing them to daylight for 5 minutes. The lower curves on the left represent the galvanometer readings on the duplicates of the above samples which were carried through the procedure without excluding daylight. The similarity of the curves obtained from the second and third experiments to those of Mangan and Mason and of Persky and Roston is apparent. It can also be seen that daylight, in addition to causing a loss of fluorescence of norepinephrine, causes a small shift in the fluorescent maxima.

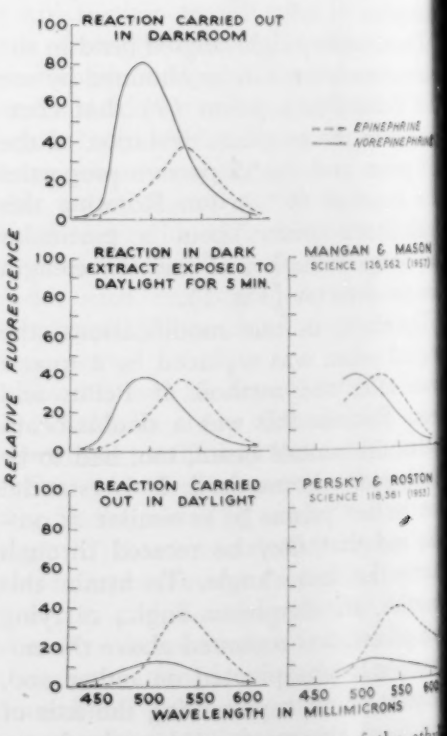

Fig. 1. Relative fluorescence of the ethylenediamine derivatives of epinephrine and norepinephrine.

little effect on the fluorescence of epinephrine was noted.

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Digestibility of Uniformly Labeled Carbon-14 Soybean Cellulose in the Rat

Reports in the literature on the fate of ingested cellulose in nonruminant animals and man present a confusing picture. Some workers (*1*) state that digestion, or utilization, of cellulose takes place to an extent varying from 1.5 to 7 percent of the ingested cellulose, while others (*2*) conclude that cellulose cannot be utilized at all. The present isotope study was undertaken in an attempt to resolve these discrepancies.

Uniformly labeled C^{14}-cellulose was prepared from defatted C^{14}-labeled soybean meal. Protein was removed from the meal by thorough extraction, first with cold water, then with 10-percent aqueous sodium hydroxide. Hemicelluloses were further extracted with 10-percent aqueous potassium hydroxide, and the residue was washed successively with water, ethanol, and ether. The dried product (specific activity, 9060 count/min mg) was used in the feeding experiment. This material contained less than 1 percent of protein and yielded no reducing sugars after 6 hours' hydrolysis in 2*N* sulfuric acid at 95°C. Since cellulose is the only major non-nitrogenous constituent present in defatted soybean meal which shows these solubility characteristics and this resistance to acid hydrolysis, the material was considered to be essentially pure cellulose.

Four growing male albino rats (Sprague-Dawley), weighing from 120 to 180 g, were selected for the feeding experiment. During the 4 days preceding the administration of labeled cellulose, the rats were fed by stomach tube a diet consisting of casein (20 percent), starch (61.5 percent), Wesson oil (10 percent), cellulose (4 percent), minerals (4 percent), and vitamins (0.5 percent). This diet was mixed with water in a ratio of 1:6 by weight to facilitate the stomach-tube feeding and was supplemented by a standard diet and water ad libitum.

Following the conditioning period, the rats were placed in metabolism cages attached to gas trains for collection of urine, feces, and expired CO_2. The above diet, with C^{14}-labeled cellulose in place of the nonradioactive cellulose, was fed by stomach tube 3 times daily; a total of 15 to 17 g of the diet-water mixture was thus administered each day for 3 days. A carmine marker mixed with the final C^{14}-cellulose feeding marked the final excretion in the feces of labeled material.

Urine, feces, and expired CO_2 were collected for each rat during the time spent in the metabolism cages. Immediately upon removal from the metabolism cages, the rats were sacrificed, with ether, and the carcasses, plus viscera, were frozen in liquid nitrogen and ground in the frozen state in a burr mill to obtain a carcass homogenate.

All of the homogenized, dried samples, with the exception of urine, were analyzed for C^{14} content by combusting to CO_2 and counting the labeled CO_2 as precipitated barium carbonate. After the dried feces were counted, this material was extracted by the Soxhlet method for 24 hours with petroleum ether (40 to 60° fraction) to remove the lipid portion. The fat-free residues were dried and analyzed for C^{14} content. The total C^{14} in feces, the petroleum-ether insoluble C^{14} in feces, and the petroleum-ether soluble C^{14} in feces (by difference) are recorded in Table 1. An aliquot portion of each urine sample was plated at infinite thinness and counted directly. All calculations were corrected for ash content of the cellulose.

Table 1. Recovery of radioactivity from uniformly labeled C^{14} soybean cellulose fed to rats.

Rat No.	Time in metabolism cage (hr)	Recovery of C^{14} (%)						
		In urine	In feces			In carcass	In expired CO_2	Total
			Petroleum ether insoluble	Petroleum ether soluble (by difference)	Total			
1	79	1.0	47.1	0.1	47.2	19.6	40.4	108.2
2	79	0.4	37.8	10.5	48.3		43.9	
3	96	1.1	42.9	1.6	44.5	9.3	57.0	111.9
4	100	2.3	39.8	13.0	52.8	7.9	45.6	108.6

Data tabulated in Table 1 indicate that a large proportion of the ingested cellulose is converted in the gastrointestinal tract to a form which the rat absorbs and metabolizes readily. The data show that only half of the C^{14} fed the rat is excreted in the feces, the rest being found distributed in the expired CO_2, carcass, and urine.

Since significant percentages of the C^{14} in the feces are present in the form of petroleum-ether soluble materials, it is apparent that the ingested cellulose, which is completely insoluble in petroleum ether, is altered as it passes through the rat's gastrointestinal tract. This finding is in agreement with work reported by others (*3*), who find that a number of microorganisms isolated from the gastrointestinal tract are able to convert cellulose, to a greater or lesser extent, to fatty acids and other metabolic products. It is quite possible that these petroleum ether extractives are among the types of cellulose degradation products which are absorbed into the rat tissues. If this is the case, it seems likely that the production of the absorbable materials from cellulose is a result of intestinal bacterial action rather than of the action of enzymes arising in the rat's own digestive juices.

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10 January 1958

Serum Lipids in Adult Twins

The possible role of lipid metabolism in the etiology of atherosclerosis has focused attention upon environmental, mainly nutritional, factors which may affect lipid levels in serum (*1*). This report is concerned with the influence of heredity upon variations in lipid levels in serum (*2, 3*). Since genetic differences are a known factor in twins, twins have been used for the study of the problem.

Caucasian twin pairs ranging in age from 18 to 55 years, from a low- to upper-middle income population in New York City, have been studied. Their health status has been established by thorough health histories and by medical examinations (*4*). Determination of total serum cholesterol, cholesterol esters, and phospholipids were obtained for 82 of these twin pairs who were found to be in good general health. The total cholesterol and free cholesterol in serum were determined by the Sperry-Schoenheimer method, and phospholipid was determined by means of Sperry's modification of the Fiske-SubbaRow method.

The diagnosis of twin zygosity was established by serological and morphological comparisons (*4*). Each pair was classified according to whether the two members had been living together or living apart prior to and at the time of study. Statistical comparisons were based upon mean variances, the mean *intrapair* variance being $\Sigma x^2/2n$, where x is the difference between the two members of a twin pair for the measured lipid levels in milligrams per 100 ml, and n is equal to the number of twin pairs. The mean *interpair* variances were calculated from the averages of the values for the two members of each twin pair. The mean variances obtained from these pair averages were multiplied by two to make them comparable to the intrapair variances, since the latter were based upon individuals, and the interpair variances upon means of pairs of individuals. Variance or F ratios have been calculated, and the F distribution has been used to obtain the probability levels of these ratios.

The intrapair variances of monozygotic twins did not differ significantly from those of dizygotic twins of the same sex. In every instance, however, the dizygotic variance was the larger. In both monozygotic and dizygotic twins, the variances of pairs living apart were larger than those for pairs living together. In the female monozygotic twins, the "apart" mean variances of pairs living apart were larger for total cholesterol and phospholipid at the 5-percent level of significance. It is the consistency in the direction of the ratios (monozygotic to dizygotic and "together" to "apart") rather than their actual magnitude which implies that both genetic and environmental factors influence (possibly in an accumulative way) variations in "normal" serum lipid levels.

Table 1. Mean intrapair and interpair differences in total cholesterol serum of mo zygotic and dizygotic twins living together and living apart (*8*).

Sex	Residence	Comparison	D.F.	Variance		P
			Monozygotic			
Male	Together	Intrapair	14	279.536		
		Interpair	18	2780.492	9	< .001
Male	Apart	Intrapair	5	340.100		
		Interpair	18	2780.492	8	< .025
Female	Together	Intrapair	14	205.821		
		Interpair	23	1960.290	9.	< .001
Female	Apart	Intrapair	10	602.050		
		Interpair	23	1960.290	3.26	> .025
			Dizygotic			
Male	Together	Intrapair	6	694.250		
		Interpair	6	1519.144	2.19	> .10
Female	Together	Intrapair	9	365.611		
		Interpair	21	1498.178	4.10	> .01
Female	Apart	Intrapair	13	868.615		
		Interpair	21	1498.178	1.73	< .25
Unlike Sex	Together	Intrapair	5	302.500		
		Interpair	8	2022.000	6.68	> .025
Unlike Sex	Apart	Intrapair	4	1090.625		
		Interpair	8	2022.000	1.85	> .25

In Table 1 the mean intrapair and interpair differences in total cholesterol content of the serum are compared. In monozygotic twins living together, genetic identity and the greatest environmental similarity seen in this study are contrasted with the statistical equivalent of unrelated people. At the other extreme are the dizygotic twins living apart; their ratios contrast the greatest genetic and environmental dissimilarity observed in this sample with the statistical equivalent of unrelated people. Whereas the first extreme provides the largest F ratios, 9.52 to 9.95, the latter shows the smallest F ratios, 1.73 to 1.85. Between these extremes there is a range of variation as genetic and environmental differences change in monozygotic twins living apart and dizygotic twins living together. A parallel analysis for cholesterol esters and phospholipids provides results comparable to those presented for total serum cholesterol (*5*).

The present analysis demonstrates that variation of lipid levels in serum results from both genetic and environmental influences (*6*). It further indicates the relative magnitude of these influences necessary to produce statistically measurable variations in lipid levels in serum of an adult population in essentially good health. Significant effects were obtained when the genetic and environmental differences of people who are unrelated were contrasted (i) with genetically identical people with environmental differences limited by a common family background and (ii) with people of the first degree of relationship sharing a common home environment. The latter observation is comparable to the findings a study of families reported by Adlersberg, Schaefer, and Steinberg (*7*).

In conclusion, the present findin demonstrate the importance of both g netic and environmental factors in t regulation of lipid levels in serum. may be assumed, therefore, that genet factors will not be equally important all environments and that the enviro mental tolerances of one population w not equal those of another population.

Richard H. Osborn
David Adlersbe
Institute for the Study of Human Variation, Columbia University, New York, and *Departments of Medici* and *Chemistry, Mount Sinai Hospit New York*

References and Notes

1. A. Keys and P. D. White, *Cardiovascular E demiology* (Hoeber-Harper, New York, 195
2. Acknowledgment is given to the Presbyteri Hospital Blood Bank and the Department Medicine of the Columbia-Presbyterian Me cal Center and to Frances V. DeGeorge, C. Wang, L. E. Schaefer, and S. R. Drachm for assistance. The study was supported by t Commonwealth Fund of New York (R. H. O borne) and by the U.S. Public Health Servi Division of Grants and Fellowships (D. Adle berg).
3. A detailed report on the investigation of seru lipids in twins is in preparation.
4. R. H. Osborne, "Hereditary and environme tal factors in body build: a study of 100 pai of adult twins" (Dissertation Abstracts, U versity Microfilms, Ann Arbor, Mich., 1956).
5. A description of the results is in preparation.
6. A heritability ratio could be computed fr our data to indicate the proportion of the to variances which can be accredited to hered versus environment. Because of reservati concerning this ratio, this computation has n been done.
7. D. Adlersberg, L. E. Schaefer, A. G. Steinber *Circulation* **16**, 487 (1957).
8. No comparison of male dizygotic twins livi apart is possible, for only two pairs of ma dizygotic twins living apart were obtained f study.

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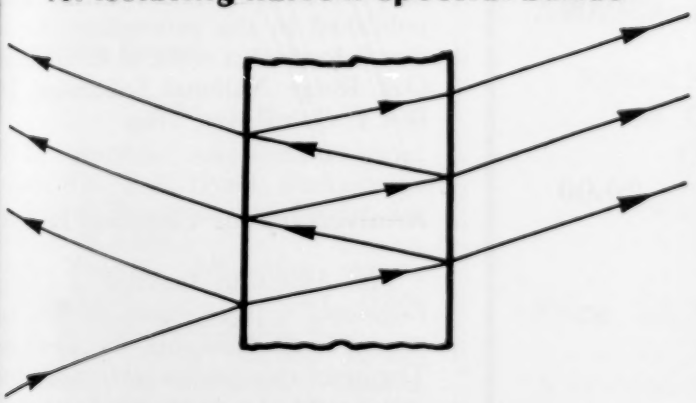

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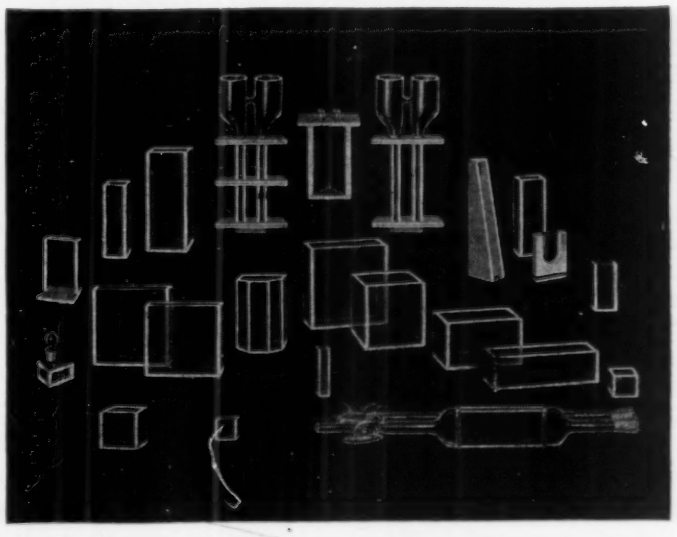

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Meetings

Arid Lands Conference

The UNESCO–Iran Symposium on Salinity Problems in the Arid Zones will be held in Teheran, 11–15 October. Under the Arid Zone Program of UNESCO, symposia on subjects of topical interest in arid zone research, such as hydrology, plant ecology, wind and solar energy, or climatology, have been organized each year. The advisory Committee on Arid Zone Research, at its 11th session, suggested that a symposium should be organized to deal with problems of salinity of land and water, especially with reference to the purification of salt water and the utilization of saline water by plants and animals. The Iranian Government offered to be host to the symposium, the aim of which is to bring together a number of scientists to present and discuss original research papers on these problems.

The Iranian Government will invite selected participants from countries in North Africa, the Middle East, and South Asia. UNESCO will ensure the participation of a number of scientists from other parts of the world. It is hoped that, in addition, some specialists will be able to attend at their own or their institutions' expense. The total participation will not exceed 60 persons.

The Natural Science Department of UNESCO, 19 Avenue Kléber, Paris 16, will be responsible for the coordination and scheduling of contributions so as to achieve a well-balanced program. Some of the participants invited by UNESCO will be asked to present papers of a more general character to serve as an introduction to the various sections.

The Iranian Government has established an organizing committee that is responsible for all the local arrangements. The executive secretary of the committee is Prof. H. Behnia, Rue Hadjani, Avenue Parse, Teheran.

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Nuclear Reactor Technology

The Oak Ridge National Laboratory has announced that the second conference in a series of unclassified meetings on the role of analytical chemistry in nuclear reactor technology will be held in the Civic Auditorium at Gatlinburg, Tenn., 29 September–1 October. This meeting is a continuation of the first conference, which was held at Gatlinburg in November 1957. Any worker in the field who feels that he has some worthwhile contribution to offer is invited to participate in the program. Papers that may require up to 30 minutes for presentation will be considered. Abstracts of approximately 200 words should be submitted *by 1 July*. All manuscripts received *before 1 October* will be published in the proceedings. For further information write to C. D. Susano, Oak Ridge National Laboratory, P.O. Box Y, Oak Ridge, Tenn.

Anniversary for Chemical Engineers

The American Institute of Chemical Engineers will celebrate its 50th anniversary in Philadelphia, Pa., 22–27 June. Theme of this golden jubilee celebration will be "A Look to the Future." The technical program will summarize 50 years of progress in chemical engineering. There will be more than 80 papers in 13 different symposia. A keynote address will be delivered at a special session by Monroe E. Spaght, executive vice president of Shell Oil Company. Crawford H. Greenewalt, president of E. I. duPont de Nemours, will address the banquet.

American Nuclear Society

A total of 190 papers will be presented in 24 sessions at the fourth annual meeting of the American Nuclear Society,

Los Angeles, Calif., 2–5 June. The Statler Hotel will serve as headquarters, and [illegible] E. Parkins is local program chairman. The program includes two special sessions: one on radiation damage in metallic fuels and a second on shielding. Other sessions will concern all phases of nuclear science and engineering. Two sessions of the Nuclear Codes Group will be held concurrently with the meeting.

This is the first ANS meeting to be held on the West Coast, and the Southern California Section will act as local host. Chauncey Starr, vice president of Atomics International, is honorary chairman, and W. R. Hainsworth, vice president for research of the Fluor Corporation, Ltd., is general chairman. Between 1200 and 1500 scientists and engineers are expected to attend. For information, write to the American Nuclear Society, Inc., Box 963, Oak Ridge, Tenn.

Mucopolysaccharides

A Conference on the Chemical and Physical Structure of Mucopolysaccharides will be held 5–6 June at Castle Hill, Ipswich, Mass. The conference is sponsored by the National Science Foundation and organized by the Retina Foundation. The proceedings will not be published. In addition to the 40 invited participants, only 20 scientists may attend because of the limitations of space and accommodations. For further information write to Dr. Endre A. Balazs or Dr. Roger Jeanloz (program directors) at 30 Chambers St., Boston 14, Mass.

Forthcoming Events

June

29–2. American Astronomical Soc., Madison, Wis. (J. A. Hynek, Smithsonian Astrophysical Observatory, 60 Garden St., Cambridge 38, Mass.)

29–4. National Education Assoc., Cleveland, Ohio. (W. G. Carr, NEA, 1201 16 St., NW, Washington 6.)

30–5. High Energy Nuclear Physics Conf., annual (by invitation), Geneva, Switzerland. (CERN, Geneva 23.)

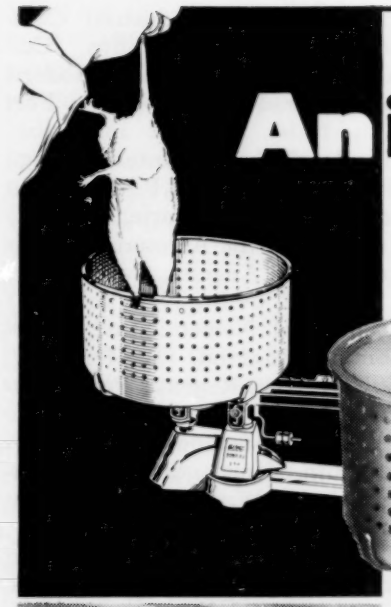
July

4–6. Astronomical League, Ithaca, N.Y. (Miss W. A. Cherup, 4 Klopfer St., Millvale, Pittsburgh 9, Pa.)

6–12. Cancer Cong., 7th intern., London, England. (H. F. Dorn, National Inst. of Health, Bethesda 14, Md.)

6–12. Research and Development Engineering Seminar, 2nd annual, University Park, Pa. (Extension Conference Center, Pennsylvania State Univ., University Park.)

7–9. Exchange of Knowledge in a Divided World, Chicago, Ill. (H. W. Winger, Graduate Library School, Univ. of Chicago, Chicago 37.)



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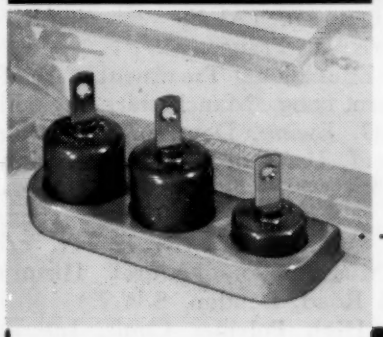

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7–12. Nuclear Physics, intern. cong., IUPAP, Paris, France. (C.I.P.N., Institut du Radium, II, rue Pierre Curie, Paris 5e.)

8–11. Institute of the Aeronautical Sciences, summer, Los Angeles, Calif. (S. P. Johnston, IAS, 2 E. 64 St., New York 21.)

9–15. Zoological Nomenclature Colloquium, London, England. (F. Hemming, 28 Park Village East, Regent's Park, London, N.W.1.)

10–14. Research Methods in Soil Zoology, colloquium, Harpenden, Hertfordshire, England. (P. W. Murphy, Rothamsted Experimental Station, Harpenden.)

15–22. Association Française pour l'Avancement des Sciences, 77th cong., Namur, Belgium. (AFAS, 28, rue Serpente, Paris VIe, France.)

15–23. Educational Treatment of Deafness, Intern. cong., Manchester, England. (A. W. G. Ewing, Dept. of Education of the Deaf, Univ. of Manchester, Manchester 13.)

16–23. Zoology, 15th Intern. cong., London, England. (H. R. Hewer, c/o British Museum of Natural History, Cromwell Road, London, S.W.7.)

21–24. High Polymer Conf., Intern., Nottingham, England. (Conference Secretariat, Dept. of Scientific and Industrial Research, Charles House, 5–11, Regent St., London, S.W.1.)

24–25. Computers and Data Processing, 5th annual symp., Denver, Col. (Electronics Div., Denver Research Inst., Univ. of Denver, Denver 10.)

25–29. Chromatic Discrimination in Animals and Man, ICSU symp., Paris, France. (H. Pieron, Collège de France, Place Marcelin-Berthelot, Paris 5e.)

28–30. Regulation of Cell Metabolism, Ciba Foundation symp. (by invitation), London, England. (G. E. W. Wolstenholme, 41 Portland Pl., London, W.1.)

28–2. Home Economics, 9th intern. cong., College Park, Md. (Congress Director, American Home Economics Assoc., 1600 20 St., NW, Washington 9.)

28–8. Statistical Summer Seminar, Dedham, Mass. (I. Weiss, Bell Telephone Labs., North Andover, Mass.)

August

7–9. Electron Microscope Soc., annual, Los Angeles, Calif. (C. M. Schwartz, Battelle Memorial Inst., 505 King Ave., Columbus 1, Ohio.)

10–16. Radiation Research, intern. cong., Burlington, Vt. (H. M. Patt, Argonne National Lab., P.O. Box 299, Lemont, Ill.)

13–15. Electronic Standards and Measurements Conf., Boulder, Colo. (J. F. Brockman, National Bureau of Standards, Boulder.)

13–19. Seaweed Symposium, 3rd Intern., Galway, Ireland. (C. O. hEocha, Chemistry, Department, University College, Galway.)

13–20. International Astronomical Union, 10th general assembly, Moscow, U.S.S.R. (P. Th. Oosterhoff, IAU, Leiden Observatory, Leiden, Netherlands.)

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■ LINEAR RATE METER converts random spaced input pulses into an average count-rate per minute. Count rate is indicated in seven linear ranges or in logarithmic scale. The latter permits initial estimates over a range of 30 to 300,000 count/min to guide selection of the optimum linear scale. Output is available for operation of a chart recorder. (Technical Associates, Dept. 7[illegible])

■ NUCLEAR-MAGNETIC-RESONANCE SPECTROMETER achieves improved resolution and increased sensitivity by operating in the 60-Mcy/sec frequency range instead of the 40-Mcy/sec range. This change is made possible by the development of a new magnet producing a field of 14,092 gauss with the same absolute field uniformity and stability as the previously used 9400-gauss field. Additional features of the new instrument are reduced sensitivity to room- and water-temperature fluctuations and the capability of operating over a wide range of field strengths. (Varian Associates, Dept. 7[illegible])

■ PROJECTION METER combines a meter movement, 0- to 1-ma d-c in a standard instrument, and a projector as a unit. The instrument is used on the lecture table along with associated equipment. The meter movement is protected from heat by being located at the bottom of the instrument. Interchangeable scales are available in many ranges. Scale length at projection distance of 6.5 ft is 30 in. (Williamson Development Co., Inc., Dept. 79)

■ FREQUENCY CHANGER provides power of variable frequency for equipment drawing up to 100 va. Frequency range is 45 to 2000 cy/sec. An auxiliary input permits use of an external signal of precise frequency to control the output frequency. Input voltage range is 105 to 125 v at 45 to 65 cy/sec. Output voltage is 0 to 135 v with ± 1 percent regulation for line or load variations. Distortion is 1 percent maximum over the output range 75 to 125 v at temperatures from 0 to 40°C ambient. (Sorensen and Co., Inc., Dept. 80)

■ PULSE-HEIGHT ANALYZER scans continuously between base-line settings of 0 and 100 v, with a complete scan representing 20 in. of recorder paper travel. Chart speed may be varied from 7.5 to 2[illegible] in./hr. The instrument combines a direct-writing strip-chart recorder, a linear amplifier and single-channel pulse-height

alyzer, and a rate meter with scale ges of 300 100,000 counts/min. The rate meter permits selection of 1, or 10 percent probable error range. Technical Measurement Corporation, Dept. 57)

TEMPERATURE RECORDER, requiring no external power source, is said to be resistant to shock and vibration and to provide measurement accuracy ±1 percent of range. A spring-wound chart drive provides 8-day operation. (Partlow Corp., Dept. 66)

COPYING MACHINE ADAPTER permits kymograph records of width up to 14-in. and of indefinite length to be copied continuously by the "Thermofax" process at approximately 0.25 ft/sec. The adapter is placed in front of the copying machine for use. No installation is required. (Minnesota Mining and Manufacturing Co., Dept. 67)

AUTOMATIC TITRATOR can cover a wide variety of titrations, including those involving *p*H and dead-stop end-points. The results of the titration are presented in digital form or as a chart record. The instrument consists of three interconnected units: a titration-control unit containing end-point circuits; a sequence-control unit; and a burette unit, including sampling devices, reaction vessel, meniscus-finding mechanism, and record presentation system. Devices are available for sampling a continuous source or for individual samples. Alternative amplifiers are suitable for *p*H, redox, and similar titrations and for dead-stop titrations. The latter is sensitive enough for use of 0.1*N* iodine solutions. The burette, of 50-, 25-, or 10-ml capacity, is read by a photoelectric meniscus follower. Results, in the form of typed record, include volume of titrant, time of titration, and other information, as desired. Adjustments are provided to permit recording of actual answer rather than volume of titrant. (Baird & Tatlock Ltd., Dept. 74)

■ GAUSSMETER utilizes the Hall-effect principle to measure magnetic flux up to 50,000 gauss in static or a-c fields. Nine full-scale ranges are provided to cover the total range. Accuracy is ±3 percent. Two standard magnets, calibrated to ±1 percent, are furnished for calibration at 1000 and 5000 gauss. The instrument uses transistors throughout. (Radio Frequency Laboratories, Inc., Dept. 72)

■ DIGITAL DISPLAY CONVERTER attaches to decimal counters that display each decimal digit on a vertical array and translates to an in-line display. The device operates photoelectrically, reading the illuminated indicators on the face of the counter; thus it can be used with counters that do not have circuit termination provision for in-line read-out matrix decoding. (Radio Frequency Laboratories, Inc., Dept. 73)

■ MICROPROJECTOR can project the image of a microslide object on a horizontal table top or a vertical screen. In either mode of operation, slides are held horizontally so that fluids can be studied. The unit weighs 10 lb and stands 27 in. high. (Herrick Machine Works, Dept. 70)

■ OXIDATION UNIT permits determination of oxygen absorbed by rubber, plastics, or other materials on exposure to air or oxygen. Fourteen sample tubes, each equipped with a gas buret and leveling bulb, are provided. The tubes and burettes are thermostated to ±0.1°C; temperature is adjustable to 400°C. (G. F. Bush Associates, Dept. 69)

■ PRINTING COUNTER counts up to 500 count/min. Print-out to five digits, on paper tape, is initiated by means of a push button on the unit or by means of a remotely located contact closure. Print-out may automatically reset the counter, or cumulative totals may be carried. (Royson Engineering, Dept. 68)

THE SPECIES PROBLEM

AAAS SYMPOSIUM VOLUME NO. 50
Edited by Ernst Mayr, Harvard University
6 x 9 in., 404 pp., references, index, clothbound, October 1957
Price $8.75; special cash order price for AAAS members $7.50

The symposium was arranged by the Association of Southeastern Biologists and cosponsored by AAAS Sections F and G, as well as four other societies. Most papers are published essentially as given in Atlanta in December 1955. Dr. T. M. Sonneborn, however, undertook a comprehensive survey of the species problem in the protozoans and particularly the ciliates. His masterly synthesis comprising more than two-fifths of the volume is a fundamental contribution to the protozoan literature.

This symposium made a solid contribution toward the solution of the species problem. It broadened the base on which to discuss the problem by utilizing new organisms. It led to a clarification of the areas of general agreement among biologists. It presented a clear statement of the various species concepts and frankly stated and enumerated difficulties in their application to different types of natural populations. Finally, it illumined certain aspects of the ageless species problem that had been neglected previously, and it attempted a statement of still controversial issues. From these papers it should be evident that the species problem is still one of the important issues in biology.

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